Review copy

RCRA RECORDS CENTER
FACILITY CIBA-GEIGY
I.D. NO. RID001194323
FILE LOC. R-9
OTHER

RCRA Facility Investigation

CIBA-GEIGY Facility
Cranston, Rhode Island

Draft Stabilization Design Documents

Operation and Maintenance Manual

Submitted By
CIBA-GEIGY Corporation
444 Sawmill River Road
Ardsley, New York 10502

Volume 3 of 4

November 1993
Project No. 87X4660D

RCRA Facility Investigation

CIBA-GEIGY Facility
Cranston, Rhode Island

Draft Stabilization Design Documents
Operation and Maintenance Manual

Submitted By
CIBA-GEIGY Corporation
444 Sawmill River Road
Ardsley, New York 10502

Volume 3 of 4

November 1993
Project No. 87X4660D

TABLE OF CONTENTS

SECTION 1

1.0 INTRODUCTION

CIBA-GEIGY Corporation (CIBA-GEIGY) has retained Woodward-Clyde Consultants to prepare this Operation and Maintenance (O&M) Manual for the groundwater capture, groundwater pretreatment, and soil vapor extraction systems (SVES) at the Cranston, Rhode Island facility. The O&M manual is organized into the following sections:

Section 1	-	Introduction
Section 2	-	Safety and Housekeeping
Section 3	-	System Description
Section 4	-	Control Loop Descriptions
Section 5	-	System Operation
Section 6	-	Maintenance and Repair
Section 7	-	Potential Operating Problems
Section 8	-	Sampling/Laboratory Testing Protocol
Section 9	-	O&M Costs
Section 10	-	Record Drawings
Section 11	-	Equipment and Vendor Information

Only portions of the above sections have been prepared at this time, since the design phase is still in progress and equipment has not yet been specified or purchased. As a result, specific operation and maintenance information is not yet available and complete operating and maintenance procedures can not be developed at this time.

As process equipment is specified and/or purchased, the O&M manual will be further developed. During startup, the O&M manual will be checked and revised accordingly. The final O&M manual will be issued at that time, based on as-built conditions.

SECTION 2

This section presents safety, housekeeping and emergency response procedures. The term "facility" in this section refers to the groundwater pretreatment system and the SVES. It is a requirement that operators are properly trained in these procedures.

2.1 INTRODUCTION

The purpose of this section is to describe common safety procedures and practices. Adherence to good safety practices is essential in reducing accidents and injuries. Accidents and injuries are often caused by the following factors:

- Personnel do not have the appropriate safety equipment or do not use the appropriate equipment.
- Personnel do not follow safety rules either through ignorance or negligence.
- Personnel do not understand or are not trained in the dangers and risks involved with equipment and chemicals.

2.2 STANDARD SAFETY PRACTICES

The following standard safety practices will be followed at the facility. Operators must be thoroughly familiar with and trained on the following safety practices.

2.2.1 Personal Hygiene

There are always inherent risks when working around chemicals and machinery. However, these risks can be reduced greatly if standard personal hygienic habits are used; these personal hygiene habits include:

- Do not eat or drink within the facility at any time.
- Do not smoke within the facility at any time.
- Wear proper protective clothing, including required protective equipment.

2.2.2 Protective Equipment

Protective Clothing

Personal protective clothing includes articles such as gloves, hard hats, safety glasses, safety shields, steel-toed work boots, and coveralls. This equipment is used to protect the body from injury and from hazardous materials and machinery.

The following protective clothing will be worn:

- Hard hats and safety glasses must be worn at all times while inside the facility.
- Steel-toed work boots will be worn at all times within the facility.
- Gloves and coveralls will be worn within the facility.
- Rubber gloves, safety shields, and aprons will be worn when handling corrosive or caustic chemicals or when working in or around tanks, pumps, or pipes containing such material.
- Rubber boots will be worn in wet places.

LOOSE CLOTHING THAT CAN GET CAUGHT IN MACHINERY MUST NOT BE WORN.

Protective Devices

Protective or safety devices that will be readily available are as follows:

- Lighting

  Non-sparking and explosion-proof flashlights and explosion-proof electrical lighting with heavily insulated, corrosive resistant cords will be used in potentially explosive areas. — WHERE & WILL THESE AREAS BE MARKED

- Ventilating Blower

WILL THESE AREAS BE MARKED?

FOR WORK IN A HAZARDOUS (EXPLOSIVE, CORROSIVE, OR OXYGEN-DEFICIENT) ATMOSPHERE AND CONFINED SPACES, IT IS NECESSARY TO REMOVE DANGEROUS GASES AND VAPORS RATHER THAN USE A PROTECTIVE MASK OR OTHER RESPIRATORY DEVICE. The dangerous gases may be removed by natural draft or by forced ventilation using a portable blower. If a blower is used to exhaust an **explosive or corrosive atmosphere**, it should be explosion-proof or have a vapor-proof, totally enclosed motor, or non-sparking gas engine. If possible, the blower should be kept out of the explosive/corrosive atmosphere. Ventilation should be continuous to prevent build-up of gases.

- Gas Mask (Air Purifying Respirator) and Self-Contained Breathing Apparatus (SCBA)

Canister gas masks can be used for low concentrations of certain gases, vapors, smokes, and dusts, provided there is sufficient oxygen in the atmosphere. The mask must be used with the proper canister for each gas or mixture of gases expected. Operators must be fit-tested for the mask to be used at the facility and medically evaluated by a physician prior to wearing a mask.

A SCBA will give respiratory protection against all gases, vapors, dusts, smoke, and oxygen deficiency. Prior to use of any respirator or SCBA, operators must be medically evaluated by a physician.

- Gas Detectors

The operator will always pay attention to unusual odors or irritants in the air. Whenever the presence of gas is suspected, the air should be tested with the appropriate instrument (i.e., explosimeter, Compressed Gas Indicator (CGI)). An unknown atmosphere must not be tested with sparking devices, matches, or flames.

- First Aid Kits

  First aid kits will be readily available and kept well stocked with supplies and equipment.

- Fire Extinguishers

  Operators will become familiar with the exact use and location of fire extinguishers. All extinguishers will be tested at least annually and contain a proper inspection tag.

2.2.3 Safety Procedure for Specific Hazards

<u>Electrical Hazards</u>

- General Precautions

  If equipment is not functioning properly and an electrical problem is suspected, the ELECTRICAL EQUIPMENT MUST NEVER BE PROBED WITH A SCREWDRIVER OR OTHER METALLIC OBJECT. The area must always have electrical protective rubber mats on the floor and it is suggested that the workmen wear rubber boots. No electrical work will ever be performed in or around the facility during an electrical storm. All electrical equipment will have proper insulation and only tools which are double insulated or have 3-wire grounded extension cords will be used. Ground fault circuit interrupters (GFCI) will be used in wet areas. Electrical work, in all cases, will be performed by qualified electrician.

- Work Procedures

  WHENEVER ELECTRICAL WORK IS TO BE PERFORMED, POWER TO THE WORK AREA WILL BE DE-ENERGIZED. It will then be locked out and tagged following OSHA procedures. Two men should always be present for electrical work so that one can summon help in the event of an emergency.

- Mechanical Equipment Hazards

Operators must keep their hands and clothes clear of moving equipment and parts.

A list of precautions which must be considered when working with mechanical equipment is presented below:

(1) Guards, such as screens covering blades of ventilating blowers, guards over fan belts, screens around motor shafts, or aluminum grating over open tanks will be kept in place. Guards must always be replaced if removed for maintenance or repair operations.

(2) Equipment will only be lubricated when not in operation, unless lubrication while operating is required for a specific piece of equipment.

(3) When maintenance or repair must be performed on equipment with remote or automatic control, it is imperative that all such controls be properly locked out and tagged by the worker. Upon completion, the worker will remove the lock and tags.

(4) Lifting equipment will be available and utilized when heavy objects are to be relocated. Hand trucks, dollies, chain hoists, and fork lifts will all be used for moving heavy objects to avoid back and/or muscle injury.

(5) The tools utilized for repair and/or maintenance operations will be kept in good working order. Safety equipment and tools will be used with the same precautions observed while operating mechanical equipment. Tools will be used for their intended use

only (i.e., a screwdriver should not be used as a crowbar, a wrench should not be used as a hammer, etc).

(6) Floors, grating, and handrails will be kept clean to avoid slippage.

(7) Permanent warning signs will be kept in place at all times to warn workers and visitors of potential hazards.

(8) Flammable materials will be properly stored in suitable containers.

(9) A ladder properly secured to a permanent fixture will be used when working in open tanks. Slippage at the foot of the ladder should be prevented.

(10) Low headroom areas or protruding objects should be properly padded, and clearly visible warning signs posted. Hardhats should be donned in these areas.

- Noise Level Considerations

Protection against the effects of noise exposure will be provided when sound levels exceed the permissible noise exposures. A Hearing Conservation Program must be implemented as per OSHA standards if noise levels exceed OSHA standards.

- Explosion and Fire Hazards

  - Source of Ignition

Any combustible gas will burn, but only if sufficient oxygen and a source of ignition are present. The source of ignition can be a spark, a flame or the buildup of a temperature equal to or greater than the ignition temperature of the gas or vapor. If a burning combustible gas is not of sufficient temperature to ignite neighboring layers of gas, an explosion may not result.

When a gas explosion occurs, a substantial pressure is exerted on surroundings. The propagation of a flame from one layer of gas to the next in an explosion requires the concentration of gases to be within certain limits, usually expressed as a percent by volume with respect to air.

Concentration of gas above or below these limits precludes the spread of a flame from the source of ignition. Removal of the source of ignition will extinguish the gas flame. The above mentioned limits are known as the flammable limits if the progression of flame from one layer to the other does not produce pressure or violence.

- Detection

A combustible gas indicator (CGI) can be used to measure the concentration of combustible gases present in an atmosphere. A sample is drawn into the device. The scale is graduated in percentage of the lower explosive limit. Calibration of the meter is to be performed as per the manufacturer's instructions.

Natural gas from leaking mains and services can enter the sewer through the soil and produce an explosive mixture. The presence of hydrogen, carbon monoxide, methane, and/or ethane often means that utility gas is entering the sewer.

- Safety Precautions

To prevent the dangers of gas buildup, confined areas should be ventilated to remain free of gas and to provide fresh air regularly. Nothing but explosion-proof electrical equipment should be used where there is any possibility of an explosive atmosphere. Exposed knife switches and open bus bars on switchboards are serious hazards in an explosive area.

- Fire Hazards

The danger of a fire is always present where flammable liquids, gases and materials are present. Smoke and toxic gases may build up to such a degree that a serious hazard to life exists. The proper fire extinguisher must be used for the specific type of fire encountered. Fire extinguishers will be kept in an unobstructed place and will be the correct type for the fires that may be encountered (refer to Table 1). Only proper fuel storage containers will be used; these will be stored well out of range of possible sources of ignition. Oily rags will be discarded in containers with self-closing lids, worn electrical wiring repaired or replaced, and all flammable cleaning solutions stored in their proper place.

- What to Do in Case of a Fire

(1) If a fire should break out, it must be quickly extinguished using the correct type of extinguisher for the type of fire (refer to Table 1)

(2) If an electrical fire is encountered, the electrical power should be shut off.

(3) At the onset of a fire, call the fire department and notify the personnel on the emergency phone list.

(4) Operators will stay near the site, in a predetermined area (a safe distance away) and give the fire department any information or help they require.

2.2.4 Safety Procedures for Chemical Hazards

Sodium Hydroxide Solution (Liquid Caustic Soda) Hazards

- Identification

  (1) Chemical Name: Sodium Hydroxide (NaOH)
  (2) Common Names: Caustic Soda, Caustic, and Lye
  (3) Appearance Characteristics: Milky white or light grey.

- Properties

  (1) Caustic soda corrodes clothing, leather, and some metals, such as aluminum, tin, lead, zinc, iron, and copper, and alloys containing these metals. It produces severe burns, and it is harmful to all human tissue.

  (2) Caustic soda is very reactive, and considerable heat is generated when water is added to it. Boiling and spattering may result. Explosions may occur if concentrated acid is added to concentrations of caustic soda. It is also very slippery on concrete.

  (3) Contact with the eyes, either in solid form or in solution, causes severe eye damage. Caustic soda is very injurious to the eyes because it continues to soak into the tissue long after initial contact. Inhalation of dust or mist of caustic soda is capable of causing injury to the entire respiratory tract. Swallowing caustic soda will result in severe injuries. Signs and symptoms of injury are frequently not evident immediately after contract. Contact of dust or mist with eye, nose, or throat tissue usually causes a stinging sensation momentarily.

- Control

  (1) A readily accessible, well-marked, rapid-acting safety shower and eye wash fountain should be located in each area where caustic soda is handled. Memorize their location and learn how to operate them. Inspect and test them periodically to be sure they function properly.

  (2) Eating, drinking and smoking are not allowed while working around or handling caustic soda. Personal protective clothing will be worn at all times when handling, pumping, diluting or moving quantities of caustic soda or when related equipment (e.g., metering pumps) is being maintained.

- Personal Protective Equipment

  Operators who are exposed to caustic soda should be equipped with proper eye and skin protection as follows:

  (1) Close-fitting industrial goggles and face shield.
  (2) Rubber gloves and apron.
  (3) Rubber safety toe shoes or boots.
  (4) Hard hat and face shield.

- Fire and Explosion Hazard Information

  (1) DO NOT use water to extinguish fires around caustic soda.

- Spill or Leak Procedures

  (1) Evacuate Area.
  (2) For large spills, NOTIFY FIRE DEPARTMENT of the chemical spilled and other proper authorities and evacuate contaminated area.

(3) For small spills, wear SCBA, hard hat with safety shield, rubber boots and apron, and heavy rubber gloves during clean up. Dilute the caustic soda with large quantities of water and saturate with boric acid solution.

Sulfuric Acid Solution Hazards

- Identification

(1) Chemical Name: Sulfuric Acid (H_2SO_4).
(2) Appearance/Characteristics: Colorless, viscous.

- Properties

(1) Sulfuric acid corrodes clothing, leather, and some metals, such as aluminum, tin, lead, zinc, iron, nickel, chromium, and copper and alloys containing these metals. It produce severe burns, and it is harmful to all human tissue.

(2) Sulfuric acid is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes and skin. Inhalation may be fatal as a result of spasm, inflammation and edema of the larynx, and bronchi, chemical pneumonitis, and pulmonary edema. Symptoms or exposure may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting.

(3) Sulfuric acid is very reactive, and considerable heat is generated when water is added to it. Boiling and spattering may result. Explosions may occur if concentrated caustic soda is added to concentrated sulfuric acid.

- Control

  (1) A readily accessible, well-marked, rapid-acting safety shower and eye wash fountain should be located in each area where sulfuric acid is handled. Memorize its location and learn how to use them. Inspect and test is periodically to be sure it functions properly.

  (2) Eating, drinking, and smoking are not allowed while working around or handling sulfuric acid. Personal protective clothing will be worn at all times when handling, pumping, diluting or moving quantities of sulfuric acid or when related equipment (e.g., metering pumps) is being maintained.

- Personal Protective Equipment

  Employees who work with sulfuric acid will be equipped with proper eye and skin protection as follows:

  (1) Close-fitting industrial goggles.
  (2) Rubber gloves and apron.
  (3) Rubber safety toe shoes or boots.
  (4) Hard hat with safety shield.

- Fire and Explosion Hazard Information

  (1) DO NOT use water to extinguish fires around sulfuric acid.
  (2) If near fire containing acid, wear a SCBA.
  (3) Sulfuric acid EMITS TOXIC FUMES UNDER FIRE CONDITIONS (Sulfur Oxides).
  (4) CONTACT WITH OTHER MATERIALS MAY CAUSE FIRE.
  (5) DO NOT allow water to enter a sulfuric acid container as a VIOLENT REACTION may occur.

- Spill or Leak Procedures

    (1) Evacuate area.
    (2) For large spills, NOTIFY FIRE DEPARTMENT and other proper authorities and stay away from the contaminated area.
    (3) For small spills, wear a SCBA, hard hat with safety shield, rubber boots and apron, and heavy rubber gloves during clean up. Dilute the acid with large quantities of water and neutralize with sodium carbonate or sodium bicarbonate until the effervescence stops.

Hydrogen Peroxide Solution Hazards

- Identification

    (1) Chemical Name: Hydrogen Peroxide (H_2O_2).
    (2) Appearance/Characteristics: Colorless liquid with a slightly sharp odor.

- Properties

    (1) Irritant to eyes, nose, and throat. Skin contact can cause irritation and contact dermatitis. Eye contact can cause irritation and redness. Ingestion requires immediate medical attention.

    (2) Oxidizes iron, copper, brass, bronze, chromium, zinc, lead, manganese, silver, and catalytic metals.

- Control

    (1) A readily accessible, well-marked eye wash fountain and safety shower should be located in each area where the hydrogen peroxide is handled. Memorize its location. Inspect and test it periodically to be sure it functions properly.

(2) Eating, drinking and smoking are not allowed while working around or handling hydrogen peroxide. Personal protective clothing should be worn at all times when handling, pumping, diluting or moving quantities of hydrogen peroxide or when related equipment (e.g., monitoring pumps) is being maintained.

- Personal Protective Equipment

Employees who are exposed to hydrogen peroxide should be equipped with proper eye and skin protection as follows:

(1) Close-fitting industrial goggles.
(2) Rubber gloves and apron.
(3) Rubber safety toe shoes or boots.
(4) Hard hat with face shield.

- Fire and Explosion Hazard Information

Hydrogen peroxide is not combustible but is a powerful oxidizer.

- Spill or Leak Procedures

(1) Evacuate Area.
(2) For large spills, NOTIFY FIRE DEPARTMENT and other proper authorities and evacuate area.
(3) For small spills, wear a SCBA, hard hat with safety shield, rubber boots and apron, and heavy rubber gloves during clean up. Dilute with large quantities of water.

Polymer Solution Hazards

There are no known adverse physical or chemical effects due to contact with polymers. However, as polymers are very viscous and "slippery" in nature, care should be taken to thoroughly clean any area where a polymer spill has occurred. This is necessary to prevent slipping by persons walking in the area.

2.3 EMERGENCY INFORMATION/RESPONSE

In the event of a serious medical emergency, an ambulance should be called by dialing:

[NUMBER TO BE INSERTED]

As some situations may require transport of an injured party by other means, written directions and a map of the route to the hospital will be provided in the Health and Safety Plan, and is posted at the site Office.

2.3.1 First Aid (General)

There are basically seven major emergencies that would require immediate first aid. They are listed below along with the first aid measures to be taken. In all cases medical assistance should be called.

- Breathing

  When breathing stops from any cause such as electric shock or suffocation, start mouth-to-mouth rescue breathing at once. Medical assistance should be called at once. Proceed as follows:

  (1) Place the victim on his back.

  (2) Straighten the victim's head and tilt it back so the chin points up. To do this, place the hand closest to the head on the forehead, place two fingers of the other hand under the bony part of the lower jaw, and push jaw up into jutting out position to keep tongue from blocking the air passage. This position is essential to keep the air passage open throughout the procedure.

(3) Check for breathing 3 to 5 seconds. If there is no breathing:

(4) Place your mouth tightly over the victim's mouth and pinch his nostrils shut.

(5) Give two full breaths, pausing between the breaths. Check for breathing and pulse. Maintaining head-tilt, repeat breathing, removing mouth each time to allow the escape of air. Breathe about 12 to 15 times per minute (one breath every 5 seconds). Continue until victim breathes for himself. Be ready to resume mouth-to-mouth breathing if victim stops breathing again.

(6) Remove your mouth. Place two fingers on the Adam's apple, and slide them into the groove on the side of the neck closest to you.

(7) Feel for pulse for 5 to 10 seconds. Continue to look, listen and feel for breathing. (CPR is needed if there is no pulse. Unless you are trained in CPR, do not attempt it. Do continue mouth to mouth breathing.) If there is no air exchange, recheck jaw and head position. Continue until medical assistance arrives.

- Bleeding

(1) To stop severe bleeding apply steady pressure directly over the wound with a sterile gauze pad or compress. In this one emergency, quickness is more important than cleanliness.

(2) Do not remove the compress to see if bleeding has stopped. If blood saturates it, apply more layers of gauze or cloth. Keep pad firmly in place with a strong bandage, neckties or cloth strips.

(3) If no bandage is available, close the wound with your fingers.

(4) If the wound is in the arm or leg, in addition to applying pressure, elevate the limb with pillows, a rolled-up coat, or any object available. Keep the victim lying down until medical attention arrives.

(5) If direct pressure does not control the bleeding, press hard on the pressure point located on the inside of the leg in the groin area (femoral artery) and the inside of the upper arm (brachial artery).

(6) When all other attempts to stop serious bleeding fail, a tourniquet should be used. <u>A TOURNIQUET WILL BE USED ONLY AS A LAST RESORT FOR THE CONTROL OF LIFE THREATENING BLEEDING THAT CANNOT BE STOPPED BY ANY OTHER MEANS.</u> It must be realized that the loss of the limb is a possibility when a person without medical training applies a tourniquet. Await medical attention.

- Broken Bones

(1) When giving first aid for broken bones or fractures, do not move the patient unless necessary to guard against further injury. Kneel him comfortably and prevent shock. NEVER ATTEMPT TO SET A BROKEN BONE.

(2) When a person is found unconscious or semi-conscious, assume a possible concussion or skull fracture and call for medical attention immediately.

(3) If there is no injury to the spine or neck, place the victim flat on his back with head slightly raised and turned to one side so that blood or other fluids can flow from the mouth and the tongue will stay forward and leave the air passage free.

(4) Keep the victim comfortably warm. Loosen any tight clothing around the neck.

(5) Do not give the victim stimulants or anything else by mouth. Do not apply antiseptics.

(6) Do not move the patient's head or any part of his body if there is bleeding from the nose, mouth or ears.

- Burns

(1) When someone is badly burned, take immediate steps to relieve pain and prevent infection. All burns require medical attention.

(2) If the burn is from fire, boiling liquid, or hot metal, do not try to strip away any clothing sticking to the burn.

(3) Relieve pain by keeping air away from the burn and covering it loosely with layers of sterile clean cloth.

(4) Do not break blisters or try to clean the burn. Do not wet the dressing or apply any grease ointment or medication. Do not use cotton or any material with loose fibers.

(5) Keep the victim lying down until medical assistance arrives. Place the victim's head and chest a little lower than the rest of his body. Raise his legs if possible. If the victim is conscious and can swallow, give plenty of non-alcoholic liquids to him, preferably water.

(6) Flush chemical burns with water immediately. Apply a stream of water while removing clothing from burned area. Cover the burned area with the cleanest material available.

- Poisoning

(1) Poisoning should be suspected when there is the odor of poison on the victim's breath, discoloration of the lips and mouth, pain or burning sensation in the throat, unconsciousness, confusion, or sudden illness where access to poison is possible.

(2) In the event of eye contamination by chemicals, have the victim use the eyewash immediately for at least 15 minutes. Cover with a sterile gauze pad and call for medial assistance.

(3) **FOR A MORE DETAILED FIRST AID PROCEDURE ON A SPECIFIC CHEMICAL, REFER TO THE MSDS FOR THAT CHEMICAL AND SECTION 2.3.2. CONTACT THE POISON CONTROL CENTER.**

- Shock

(1) Shock is a condition in which many vital functions are slowed down or seriously depressed due to an insufficient flow of blood through the body. It may accompany any severe injury or emotional upset. <u>If a state of shock continues over a few hours, it may be fatal or cause permanent damage to the brain or other organs</u>. Expect some degree of shock, either mild or serious, with any kind of accident or medical emergency.

(2) Some of the SYMPTOMS OF SHOCK ARE A SUDDEN OR GRADUAL FEELING OF UNUSUAL WEAKNESS OR FAINTNESS: COLD, CLAMMY SKIN WITH BEADS OF SWEAT ON THE FOREHEAD AND PALMS; PALE FACE; RAPID, WEAK PULSE; CHILLS; NAUSEA; SHALLOW, IRREGULAR BREATHING.

(3) To treat shock, correct its cause, if possible (for example, control bleeding). Keep the victim lying down and keep his airway open. Elevate his legs if there are no broken bones and keep him warm. If conscious and able to swallow, give water or other nonalcoholic liquids, such as tea or coffee, a few sips at first, increased to a half glass at a time. Never give any fluids at all to the unconscious or semi-conscious. Do not frighten the victim. Shock may be more life threatening than the injury itself.

- Electrical Shock

(1) The amount of current does not always determine the severity and/or extent of the injury. Injuries may include shock, burns, or death. However, the higher the voltage the greater the danger. Lower voltages are also dangerous. The current's path through the body determines the extent of damage. The heart is the most vulnerable organ.

(2) Low voltage electrical shocks occur more frequently. Low voltage current is extremely hazardous when the body is wet, which can be caused from perspiration, rain, damp floors, and moisture. For a shock to occur, the body must be in contact with a ground and a live conductor.

(3) High voltage across the body will cause a non-breathing shock condition. Often victims or this type of accident can be revived if CPR or rescue breathing is promptly applied. These should be started immediately for best results.

(4) Persons that have received severe shock should be checked by a physician or kept under observation for several hours, as the shock sometimes causes damage to organs, tissues or muscular systems.

2.3.2 First Aid (For Chemical Exposure)

Sodium Hydroxide (NaOH)

- First Aid Treatment

  (1) Flush the affected areas with water for a minimum of 15 minutes and as long as one to two hours. Contaminated clothing will be removed promptly.

  (2) If five percent ammonium chloride or five percent zinc chloride solutions are on hand, wash the affected areas (except eye tissues) promptly and thoroughly with these solutions.

  (3) In case of severe burns over a large surface of the body, shock may occur. Shock will be treated promptly by placing the patient on his back, raising his feet or knees, and keeping him warm until medical attention is obtained.

  (4) If even minute quantities of caustic soda, either in solid form or in solution, enter the eyes, they must be flushed immediately and thoroughly with water for a minimum of 15 minutes. The eye lids must be held open during the flushing to ensure contact of water with all the tissues of the surface of the eye and lids. Medical assistance will be called immediately. After the first 15-minute period of irrigation is completed it is permissible to apply two or three drops of an 0.5-percent pontocaine solution or an equally effective aqueous topical anesthetic.

  (5) In the event that caustic soda is swallowed, vinegar or a 5-percent solution of ammonium chloride may be administered as an antidote. The patient will be encouraged to drink a large quantity of water without delay. After the free caustic soda has been

diluted with water or chemically neutralized (diluted vinegar or fruit juice may be given to accomplish neutralization), eggs or mineral oil may be consumed for their soothing effect. Vomiting may occur spontaneously but will not be induced.

Sulfuric Acid (H_2SO_4)

- First Aid Treatment

(1) In case of contact, flush eyes or skin with copious amounts of water for at least 15 minutes **while** removing contaminated clothing or shoes.

(2) Assure adequate flushing of eyes by separating the eyelids with fingers.

(3) If inhaled, remove person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

(4) If swallowed, wash out mouth with water, **provided person is conscious.**

(5) In case of severe burns over a large surface of the body, shock may occur. Shock should be treated promptly by placing the patient on his back, raising his feet or knees, and keeping him warm until medical attention is obtained.

(6) **Get medical attention immediately.**

(7) Call the **Poison Control Center.**

Hydrogen Peroxide (H_2O_2)

- First Aid Treatment

  (1) In case of contact, flush eyes or skin with copious amounts of water for at least 15 minutes while removing contaminated clothing or shoes.

  (2) Assure adequate flushing of eyes by separating the eyelids with fingers.

  (3) If inhaled, remove person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, given oxygen.

  (4) If swallowed, get immediate medical attention.

  (5) **Get medical attention immediately.**

  (6) Call the **Poison Control Center.**

TABLE 1
TYPES OF FIRES

Type A - Ordinary Combustibles - Extinguisher symbol: green triangle. This type of fire is fueled by materials such as wood, paper, cloth, fiber, rubber and many plastics. It can be quenched and cooled by water.

Type B - Flammable Liquids - Extinguisher symbol: red square. The fire is fueled by liquids such as paint, paint thinner, gasoline, oil, tar, solvents, flammable gases, greases and similar materials. This type of fire requires blanketing and smothering. A dry chemical foam or carbon dioxide extinguisher may be used on this type of fire.

Type C - Electrical - Extinguisher symbol: blue circle. The fire is caused by energized electrical equipment such as overheated fuse boxes, and other electrical sources and wiring. This classification refers to the source of ignition rather than to fuel as in classes "A" and "B". This type of fire requires a nonconductive extinguishing agent such as dry chemical or carbon dioxide extinguishers.

Type D - Combustible Metals - Extinguisher symbol: yellow star. The classification includes metals such as magnesium, titanium, zirconium, and sodium-potassium alloys. A fire of this type requires smothering and should be extinguished with a sodium chloride or graphite base dry powder.

SECTION 3

3.0
SYSTEM DESCRIPTION

3.1 OVERVIEW

This chapter presents system process description for:

- The groundwater capture system;
- The groundwater pretreatment system; and
- The soil vapor extraction system (SVES).

The process descriptions for each of these systems are presented below.

3.2 PROCESS

3.2.1 Groundwater Capture System

The main design criterion for the full-scale groundwater capture system is to reverse (and maintain the reversal of) the hydraulic gradient at the bulkhead from its current direction (southeast/toward the Pawtuxet River) using the lowest practical pumping rates. In order to meet this main criterion, two secondary design criteria must be met:

- Drawdown ranging from 0.5 to 1.7 feet (depending on location) will be required on the landward side of the bulkhead; and
- Changes in the groundwater level at the bulkhead caused by infiltration of precipitationwill not effect hydraulic gradeint reversal.

3.2.1.1 Description

The full-scale groundwater capture system involves a total of three recovery wells (RC-3 MISSING through RC-5), the locations of which are shown in ~~Figure 3-1~~.

SEE SHEET G-2 OF PLANS (VOL. 4)

A submersible pump will be installed in each recovery well; the discharge from each well will be conveyed to a common collection pipe which conveys the merged discharges to the full-scale groundwater pretreatment system.

A simplified process flow diagram for the groundwater capture system is presented in Figure 3-2.

MISSING

3.2.1.2 Performance Standards

The following performance standards are used for measuring compliance with the design criteria:

7

- Drawdown on the landward side of the bulkhead will be monitored by continuous measurements of groundwater levels in wells near the bulkhead. To ensure that the required drawdown is achieved at the bulkhead, two to four recovery wells will be installed along the bulkhead; and
- Changes in groundwater levels at the bulkhead caused by the infiltration of precipitation will be monitored by continuous measurements of groundwater levels near the bulkhead, however, changes in pumping rates may not occur.

Shutdowns of the full-scale groundwater capture system (either short or longer-term) shall not be conducted in a manner which adversely impacts compliance with these performance standards.

3.2.1.3 Individual Units

The groundwater recovery system, consisting of three recovery wells, is constructed as follows:

- Wells are constructed of 6-inch diameter stainless steel screens and casings.

- Well casings are stainless steel (type 304). The approximate length of casing for each well is as follows:

  RC-3 - 6 feet of casing to grade (15 to 9 ft mean sea level (MSL))
  RC-4 - 7 feet of casing to grade (14 to 7 ft MSL) and 10 feet of casing across the Silt unit (-3 to -13 ft MSL)
  RC-5 - 5 feet of casing to grade (13 to 8 ft MSL) and 17 feet of casing across the Silt unit (-2 to -19 ft MSL)

- Wells screens are Type 304 stainless steel (Johnson Filtration Systems Vee-Wire Brand) with variable slot sizes selected based on the results of the sieve tests. The approximate length of screen for each well is as follows:

  RC-3 - 20 feet of screen (9 to -11 ft MSL)
  RC-4 - 10 feet of screen (7 to -3 ft MSL) and 15 feet of screen (-13 to -28 ft MSL)
  RC-5 - 10 feet of screen (8 to -2 ft MSL) and 15 feet of screen (-19 to -34 ft) MSL

- Wells are completed using 5 foot long silt sumps.

- Gravel pack material (as provided by Jessie Morie Co.) selected using the results of the sieve analyses extends a minimum of 1 foot above and below each screened interval.

- Well heads are installed with an above ground concrete vault to contain all controls, flow meters and water level measurement instruments. Vaults are provided by the Fort Miller Co. (or equivalent).

- Each well has a dedicated Grundfos Redi-Flo Environmental submersible pump. Pump sizes are as follows:

RC-3	60 gpm rated pump (60S50)
RC-4	16 gpm rated pump (16E9)
RC-5	16 gpm rated pump (16E9)

- Well pump controls are integrated into the programmable logic controller (PLC).

- Well monitoring instruments include individual flow meters (magnetic type) and water level monitoring information are linked to a PLC.

3.2.2 Groundwater Pretreatment System

The main design criterion for the pretreatment system is to provide treatment (prior to discharge to the local publicly-owned treatment works (POTW)) for all groundwater extracted during stabilization.

3.2.2.1 Process Description

The pretreatment system is divided into three components:

A) Liquid-phase treatment,
B) Vapor-phase treatment, and
C) Sludge handling.

The process flow diagram for the groundwater pretreatment system is presented in drawing No. M-1 of the detail design drawings (Volume 4 of 4). Drawings M-2 and M-3 show the layouts of major equipment on the first (main) floor and the second floor of the warehouse building respectively. The process and instrumentation (P&I) diagram for the groundwater pretreatment system in presented as Drawing I-1.

The following unit processes are used in the full-scale pretreatment system.

A) The liquid-phase treatment portion includes:

1) Equalization/flow measurement,
2) Oxidation/pH adjustment,
3) Flocculation/clarification,
4) Sand filtration,
5) Air stripping,
6) Aqueous-phase granular activated carbon adsorption,
7) Final pH adjustment,
8) Flow measurement and totalization, and
9) Effluent sampling.

B) The vapor-phase treatment portion of the system includes:

1) Vapor dehumidification, and
2) Vapor phase granular activated carbon adsorption.

C) The sludge handling portion of the system includes:

1) Sludge thickening, and
2) Sludge dewatering.

3.2.2.2 Performance Standards

The following performance standards are used for measuring compliance with the design criteria:

- For the liquid-phase portion of the pretreatment system, the performance standards that will be used are the effluent discharge limitations prescribed in CIBA-GEIGY's current Industrial Wastewater Discharge Permit No. 0321. These pretreatment criteria have been established by the City of Cranston for the overall protection of the environment and to minimize any potential adverse impact on the POTW. The specific effluent concentration-based limitations are presented in Table 3-1. MISSING ✓

- For the vapor-phase portion of the pretreatment system, the performance standards used are the maximum emission rates promulgated by the Rhode Island Department of Environmental Management (RIDEM) - Division of Air and Hazardous Material. These emission rates have been established by RIDEM to ensure the overall protection of the environment and minimize any potential impact on human health. The emission rates are presented in Table 3-2. MISSING ✓

- For the sludge handling portion of the pretreatment system, the equipment utilized therein is selected and sized to facilitate thickening and dewatering of the solids precipitated in the treatment system to a dryness adequate for off-site landfill disposal.

3.2.2.3 Individual Unit Processes

The design criteria for each unit process employed in the full-scale pretreatment system are discussed in detail below.

A) Liquid-Phase Treatment

1) Equalization/Flow Measurement

Purpose: An equalization tank is provided to minimize drastic fluctuations in groundwater flow and constituents fed into the pretreatment system.

Equalization Tank #1:

The equalization tank is used for groundwater from the extraction wells and SVES, accumulated water from the diked area, drainage from the VES's knock-out tank, reject from the sand filter, backwash water from aqueous-phase carbon adsorbers, condensate from the dehumidifier, spent acid wash water from the washing of air stripper packing (if required), overflow from sludge thickening tank, and filtrate from the filter press.

EQUALIZATION TANK #1	
Design flow	160-170 gpm
Hydraulic retention time (HRT)	About 5 hours
Tank volume	50,000 gallons
Minimum HRT (necessary to assure efficient equalization)	3 hours
Minimum working volume	31,000 gallons
Tank dimensions	21'2" diameter 20'4" total depth (TD) 19'4" side water depth (SWD) 1'0" freeboard
Material of construction of tank	Carbon steel bolted, epoxy coated interior, painted exterior
Tank top cover	Flat, carbon steel, for volatile organic compound (VOC) emission control
Headspace of tank	Exhausted to vapor phase treatment 6 air changes of the headspace volume per hour
Additional fittings (tentative)	Level gauge, agitator support beams on top, catwalk with handrail on top, ladder with cage for access to the top of tank, 24" access manhole on top and on tank side, three baffles 120° apart, additional 150# flanged connections for process pipes, drainage lines, vapor vent, mixer shaft entry, etc.

EQUALIZATION TANK #1	
Transfer pumps	Two (2) horizontal centrifugal pumps, TEFC motor one pump operational, one standby
Secondary Containment	Concrete dike around the tank Dike capacity: 110% of both equalization tanks volume (68,200 gallons)
Concrete dike dimensions	65'(L) x 37' (W) (inside dimensions) Dike wall height: 5'6" Freeboard height: 1'8" Access ladder inside and outside
Mixer	Side entry, 10 HP, variable speed One (1) high efficiency, axial flow hydrofoil type impeller All wetted parts 316 stainless steel
Level control/alarm system	Interlocked with recovery wells, transfer pumps, and level corresponding to minimum working volume

EQUALIZATION TANK #2	
Design flow	10-20 gpm
Hydraulic retention time (HRT)	About 10 hours
Tank volume	12,000 gallons
Minimum HRT (necessary to assure efficient equalization)	6 hours
Minimum working volume	7,200 gallons
Tank dimensions	12' diameter 15'3" total depth (TD) 14'3" side water depth (SWD) 1'0" freeboard
Material of construction of tank	Carbon steel bolted, epoxy coated interior, painted exterior
Tank top cover	Flat, carbon steel, for volatile organic compound (VOC) emission control

EQUALIZATION TANK #2	
Headspace of tank	Exhausted to vapor phase treatment 6 air changes of the headspace volume per hour
Additional fittings (tentative)	Pressure gauge, level gauge, agitator support beams on top, catwalk with handrail on top, ladder with cage for access to the top of tank, 24" access manhole on top and on tank side, three baffles 120° apart, additional 150# flanged connections for process pipes, drainage lines, vapor vent, mixer shaft entry, etc.
Transfer pumps	One (1) horizontal centrifugal pump, TEFC motor
Secondary Containment	Placed in the same dike as Equalization Tank #1
Concrete dike dimensions	65' (L) x 37' (W) (inside dimensions) Dike wall height: 5'6" Freeboard height: 1'8" Access ladder inside and outside
Mixer	Side entry, 3 HP, variable speed One (1) high efficiency, axial flow hydrofoil type impeller All wetted parts 316 stainless steel
Level control/alarm system	Interlocked with recovery wells, transfer pumps, and level corresponding to minimum working volume

Flow Measurement and Recording:

Following instrumentation will be provided on the line from equalization tank to oxidation tank:

- Pressure gauge
- Flow element
- Flow indicator transmitter
- Flow totalizer/recording
- Sampling Port

Groundwater is pumped to the next (oxidation tank) unit process.

2) Oxidation/pH Adjustment Tanks

Purpose: A two-stage system is provided to oxidize the dissolved ferrous iron in the groundwater to the less soluble ferric iron. The first stage is used to oxidize the dissolve iron and adjust the pH of the groundwater (if required). The second stage allows entrained air to be released and facilitate additional pH adjustment (if required) prior to flocculation.

Stage 1 Tank:
(oxidation tank)

OXIDATION TANK	
Design flow	180 gpm
HRT	about 30 minutes
Tank Volume	6,000 gallons
Tank Dimensions	11'9" diameter 8'1" TD 0'8" freeboard
Material of construction of tank	Carbon steel
Tank bottom	Flat bottom
Tank top and cover	Flat top, for VOC emission control
Headspace of tank	Exhausted to vapor phase treatment 6 air changes of the headspace volume per hour

LEVEL CONTROL ?

OXIDATION TANK	
Additional fittings (tentative)	Agitator support beams on top, catwalk with handrail on top, ladder with cage for access to the top of tank, 24" access manhole on top and tank side, three baffles 120° apart, additional 150# conically gusseted flanged connections for process pipes, air line for oxidation, chemical feed, drainage lines, vapor vent, mixer shaft entry, etc.
Oxidant	Air
Dissolved oxygen (DO) level	3 mg/L (minimum)
Blower	Low pressure high volume
pH control	Dual probe system
pH indicators	Local and remote
Mixer	Top entry, 2 HP, constant speed One (1) high efficiency, axial flow hydrofoil type impeller Impeller diameter: 47" Shaft dimension: 2" diameter x 92" (L) All wetted parts 316 stainless steel

Groundwater flows by gravity to the deaeration/pH adjustment tank.

Stage 2 Tank
(Deaeration/pH adjustment tank)

Deaeration/pH ADJUSTMENT TANK	
Design flow	180 gpm
HRT	about 30 minutes
Tank Volume	6,000 gallons
Tank Dimensions	11 '9" diameter 8 ' 1" TD 0 ' 8" freeboard
Material of construction of tank	Carbon steel
Tank bottom	Flat bottom
Tank top and cover	Flat top, for VOC emission control
Headspace of tank	Exhausted to vapor phase treatment 6 air changes of the headspace volume per hour
Additional fittings (tentative)	Agitator support beams on top, catwalk with handrail on top, ladder with cage for access to the top of tank, 24" access manhole on top and tank side, three baffles 120° apart, additional 150# conically gusseted flanged connections for process pipes, chemical feed, drainage lines, vapor vent, mixer shaft entry, etc.
pH control	Dual probe system
pH indicators	Local and remote

Deaeration/pH ADJUSTMENT TANK	
Mixer	Top entry, 2 HP, constant speed One (1) high efficiency, axial flow hydrofoil type impeller Impeller diameter: 47" Shaft dimension: 2" diameter x 92" (L) All wetted parts 316 stainless steel

Twenty (20) percent sodium hydroxide (NaOH) solution is used to control pH. This concentration is recommended for the pretreatment system because it has a lower freeze point and its addition is easier to control. Portable tanks (totes) are used for handling sodium hydroxide. Addition of sodium hydroxide is automatically controlled by the pH controller.

Chemical Oxidation System (standby)

A chemical oxidation system using hydrogen peroxide (H_2O_2) as the oxidant is kept available as a standby system. The system is sized for 180 gpm groundwater flow. If deemed necessary (due to the presence of manganese in the groundwater), hydrogen peroxide solution is added (at a concentration of about 75 to 100 parts per million (ppm)) to the oxidation tank in lieu of blower air to facilitate complete conversion of the dissolved iron and manganese present in the groundwater to insoluble precipitates.

A thirty-five (35) percent hydrogen peroxide solution is used for the pretreatment system. Portable tanks (totes) are used for handling hydrogen peroxide.

Groundwater flows by gravity to the next (flocculation/clarification) unit process.

3) **Flocculation/Clarification**

Purpose: Flocculation/clarification of the groundwater is required for the agylomeration and removal of insoluble precipitates formed after oxidation and pH adjustment.

An inclined plate separator with integral flash-mix and flocculation zones is used.

Flash Mixing Zone:

FLASH MIXING ZONE	
Design Flow	180 gpm
Volume	70 gallons
HRT	About 20 seconds
Height	5'0"
Length, width	18" square
Polymer addition	Skid mounted system 55 gallon drum connected to the city water supply Automatic dilution of the polymer
Polymer	High molecular weight anionic polymer MAGNIFLOC®1849A Flocculant Manufacturer: American Cyanamid Company
Mixer	Fixed speed drive Clockwise rotation 1/2 HP, 115 V, single phase, 60 Hz, A.C.
Influent line	6", 150# slip-on flange
Polymer feed inlet	3/4" NPTF
Outlet weir (to flocculation zone)	Extends over the entire width (18")
Tank covers	Provided for controlling VOC emission

Flocculation Zone:

FLOCCULATION ZONE	
Design Flow	180 gpm
Volume	500 gallons
HRT	About 2.75 minutes
Height	5'0"
Length, width	4'0" square
Mixer (flocculator)	Variable speed flocculator Clockwise rotation 3/4 HP, 115 V, single phase, 60 Hz, A.C.
Inlet weir (from flash mixing zone)	18", extends over entire width of flash mixing zone
Outlet (to lamella gravity settler)	11" x 18" (height) inside dimension, rectangular
Tank Covers	Provided for controlling VOC emissions

Lamella Gravity Settler:

LAMELLA GRAVITY SETTLER	
Design Flow	180 gpm
Settling area	620 ft^2
Plate angle	55°
Effective clarification area	80% of total settling area 496 ft^2
Hydraulic rate	0.36 gpm/ft^2
Inlet (from flocculation zone)	11" x 18" (height) inside dimension, rectangular

LAMELLA GRAVITY SETTLER	
Effluent line connection	8", 150# slip-on flange
Sludge line connection (for sludge recycle stream and for stream to the sludge thickening tank)	4", 150# slip-on flange
Sludge storage tank/thickening zone	Integral with the unit

To enhance the flocculation and settling of suspended solids, a recycle flow (about 5 percent of the total influent flow) is provided from the under-flow of the inclined plate separator to the flash mixing zone. This recycle flow increases the suspended solids concentration in the groundwater to a level sufficient for proper flocculation to occur. An air diaphragm pump (controlled by the PLC) is used for conveying the recycle flow. The remainder of the sludge flow is pumped to a sludge thickening holding tank.

Groundwater flows by gravity to the next (sand filtration) unit process.

4) **Sand Filtration**

Purpose: A continuous backwash sand filter is provided in the pretreatment system to facilitate removal of the residual suspended solids and minimize clogging in the air stripping unit.

CONTINUOUS BACKWASH SAND FILTER	
Design flow	180 gpm
Filtration area	38 ft^2
Inside diameter	7'0"
Height	14'0"
Surface loading rate	4.7 gpm/ft^2

CONTINUOUS BACKWASH SAND FILTER	
Backwash system	Continuous backwashing operation Using high pressure air scour
Compressed air system	For backwash operation
Reject flow	7-10 gpm (continuous)
Air consumption	2-3 SCFM @ 15-25 psig
Sand requirement	9.5 Tons
Pressure drop	18-24"
Sand type	- Size - 1.4 mm ES, fairly round - Uniformity coefficient - 1.5 - Low acid solubility - Silica content - >= 98 % - Dry specific gravity - 2.5 - Media hardness - #7 on Moh scale - In accordance with AWWA Standard B-100
Influent line	8", 150# flange
Compressed air line	1/4" tubing
Reject line	3", 150# flange
Filtrate line	8", 150# flange
Access hatch	20" diameter (at the bottom)
Material of construction	Carbon steel
Total weight (tank with sand and water)	about 53,500 lbs.

The backwash reject is conveyed by gravity to lift station # 3, from which it is pumped to the head of the treatment system. Effluent groundwater flows by gravity to an intermediate lift station # 1 to be pumped from there to the next (air stripping) unit process.

Lift Station # 1:

LIFT STATION # 1	
Holding tank HRT	15 minutes
Operational volume	2,700 gallons
Provided volume	3,000 gallons
Diameter of tank	8'0"
Height of tank	9'0"
Freeboard	1'0"
Material of construction	Carbon steel
Additional fittings (tentative)	Level probe, catwalk with handrail on top, ladder with cage for access to the top of tank, 24" access manhole on top and tank side, additional 150# conically gusseted flanged connections for process pipes, drainage lines, vapor vent, etc.
Tank covers	Provided for controlling VOC emissions
Level switches/alarm system	Interlocked with preceding and following transfer pumps
Transfer pumps	Duplex, horizontal centrifugal, lead/lag controlled

Groundwater is pumped to the next (air stripping) unit process from lift station # 1.

5) Air Stripping

Purpose: VOCs are removed from the groundwater by air stripping.

Air Stripper: An existing air stripper with the following specifications is used in the system. However, if the effluent exceeds 90 gpm, a similar unit will be rented/leased to be operated in parallel with the existing unit to handle the additional flow.

AIR STRIPPER	
Design groundwater flow	90 gpm
Air-to-water ratio (A:W)	About 100:1
Air flow rate	About 1200 CFM
Nominal height of packing	15'0"
Diameter of column	2'0" (ID)
Influent groundwater line	2", 150# flange
Effluent groundwater line	3", 150# flange
Air outlet duct	Reducer flange from 2'0" diameter to necessary duct size
Total height	about 20'0"
Drain	2", NPTF with plug at the bottom of tower
Sump Inspection port	12" diameter
Packing type (tentative)	3-1/2" Jaeger TRIPACK®
Materials of construction	- Tower shell - 4'0" ID, fiberglass reinforced plastic (FRP) - Spray nozzle, inlet assembly - PVC - Packing support - FRP - Blower/motor assembly - steel - Blower stand, mounting platform - steel
Access fittings	- 18" diameter manway at top - ladder with safety cage
Mist eliminator	Provided for reducing relative humidity of effluent air stream
Head losses	- At distribution nozzle - 7 psi - Through the column - about 2" water column
Fan motor	1.5 HP, TEFC
Cleaning system for fouled packing	Chemical (acid) cleaning system with pH control of spent acid wash water, 93 % solution of H_2SO_4 (if required)

AIR STRIPPER	
Secondary containment	Strippers will be located at an elevated position in the concrete dike constructed around the equalization tank for secondary containment

The contaminated vapor stream emerging from the top of the air stripping tower is directed to a dehumidifier to reduce relative humidity before being treated by the vapor phase activated carbon system. After an acid washing operation of the stripper packing, the spent acid wash water is neutralized and then transferred to lift station # 3 before being pumped back to the head of the treatment system.

Effluent groundwater from the air-stripper flows by gravity to intermediate lift station # 2.

Lift Station # 2:

LIFT STATION # 2	
Holding tank HRT	15 minutes
Operational volume	2,700 gallons
Provided volume	3,000 gallons
Diameter of tank	8'0"
Height of tank	9'0"
Freeboard	1'0"
Material of construction	Carbon steel
Additional fittings (tentative)	Level probe, catwalk with handrail on top, ladder with cage for access to the top of tank, 20" access manhole on top and tank side, additional 150# conically gusseted flanged connections for process pipes, drainage lines, vapor vent, etc.
Tank covers	Provided for controlling VOC emissions

LIFT STATION # 2	
Level switches/alarm system	Interlocked with preceding and following transfer pumps
Transfer pumps	Duplex, horizontal centrifugal, lead/lag controlled

Groundwater is pumped to the next (aqueous phase granular activated carbon adsorption) unit process from lift station # 2.

6) Aqueous-Phase Granular Activated Carbon Adsorption

Purpose: To provide additional polishing of the pretreated groundwater before final discharge.

Aqueous Phase GAC:

AQUEOUS PHASE GAC	
Diameter of vessels	8'0"
Shell configuration	Two (2) vertical cylindrical pressure vessels with semi-elliptical top and bottom heads connected in series
Weight of carbon	10,000 lbs. in each adsorber
GAC fill nozzle	3", 150# flange
GAC discharge nozzle	3", 150# flange
Influent connection	6", 150# flange
Effluent or backwash line connection	6", 150# flange
Carbon bed sample probe connection	2", 150# flange extending at least 12" into the bed
Bed expansion during backwash	30 % minimum

AQUEOUS PHASE GAC	
Material of construction of shell	Carbon steel, interior with a 25 mil dry film thickness light gray vinyl ester lining for corrosion control
Pressure rating of shell	75 psig @ 150° F
Design flow	180 gpm
Design pH range	7-9 units
Compressed air systems for carbon transfer	- 100 SCFM @ 30 psig for the adsorber - 100 SCFM @ 15 psig for transport trailer
Uncontaminated water for GAC slurry	100 gpm @ 30 psig (minimum)
Uncontaminated water for backwashing	625 gpm @ 30 psig (minimum) for a minimum of 15 minutes
Drainage capability for spent carbon transfer (slurry) water	about 4,000 gallons
Drainage capability for backwash water	about 9,000 gallons
Access fittings	- 20" manway on top and on the side - ladder with safety cage
Underdrain collection system	50 polypropylene or PVC nozzles to collect the treated water at the bottom of the shell
Carbon usage rate	About 54 lbs/day
Carbon regeneration frequency	About six months (185 days actual) Twice every year

The activated carbon adsorption system has backwashing capability to prevent solids from plugging the carbon media. The backwash reject is conveyed to lift station # 3 from which it is pumped back to equalization tank #1. The drainage water generated during the carbon slurry transfer operation is also conveyed to lift station #3 before being pumped back to the head of the treatment system.

SEE P 4-14

Lift Station # 3:

LIFT STATION # 3	
HRT	about 20 minutes
Tank volume	About 2,000 gallons
Tank dimensions	6'0" (W) x 6'0" (L) x 6'0" (H) cut in the floor
Material of construction of tank	Reinforced concrete
Mixer	Top entry, 1 HP, constant speed One (1) high efficiency, axial flow hydrofoil type impeller All wetted parts 316 stainless steel
Tank covers	Provided for safety
Level switches/alarm system	Interlocked with preceding and following transfer pumps
Transfer pumps	Self priming horizontal, duplex

7) Final pH Adjustment System

Purpose: Adjust the pH to within the acceptable effluent discharge standard range.

The pH of the groundwater is decreased to within permitted limits with a dilute sulfuric acid solution after aqueous phase granular activated carbon treatment.

Final pH Adjustment Tank:

Final pH ADJUSTMENT TANK	
Design flow	180 gpm
HRT	about 15 minutes
Tank volume	3,000 gallons

Final pH ADJUSTMENT TANK	
Tank dimensions	8'0" diameter 9'0" TD 1'10" freeboard
Material of construction of tank	Carbon steel with epoxy coating
Tank bottom	Flat bottom
Additional fittings (tentative)	Level probe, agitator support beams on top, catwalk with handrail on top, ladder with cage for access to the top of tank, 20" access manhole on top and tank side, three baffles 120° apart, additional 150# conically gusseted flanged connections for process pipes, chemical feed, drainage lines, mixer shaft entry, etc.
pH control	Dual probe system
pH indicators	Local and remote
Mixer	Top entry, 1 HP, constant speed One (1) high efficiency, axial flow hydrofoil type impeller Impeller diameter: 36" Shaft dimension: 2" diameter x 72" (L) All wetted parts 316 stainless steel

8) Effluent Flow Measurement, Totalization, and Recording

Following instrumentation is provided on the effluent line:

- Magnetic flowmeter
- Flow totalizer/indicator/recorder

9) **Effluent Sampling**

An ISCO-type automatic refrigerated composite sampler is provided on the effluent line.

Discharge to POTW

Pretreated groundwater is discharged to the POTW via an existing on-site sanitary sewer system connection.

B) **Vapor-Phase Treatment**

1) **Vapor Dehumidification**

Purpose: Moisture emitted from the air stripper is reduced to optimize the performance of the vapor phase granular activated carbon treatment. Dehumidifier(s) are employed for this purpose.

Pull-type blowers are provided (as required) to provide a negative pressure atmosphere and exhaust various unit processes to the next (vapor phase granular activated carbon) unit process after dehumidification.

2) **Vapor Phase Granular Activated Carbon Adsorption**

Purpose: To treat and deodorize air discharged from the air stripper, process tanks.

Vapor Phase GAC:

VAPOR PHASE GAC	
Vessel dimensions	22'4" (L) x 8'0" (W) x 8'0" (H)
Carbon bed width	3'0"

VAPOR PHASE GAC	
Inlet duct connections	20" ID (two at each end, totally four) Each inlet capable of handling 5,000 CFM air-flow
Outlet duct connections	20" ID (four on top)
Carbon volume	425 ft^3
Carbon weight (approximate)	12,500 lbs.
Shipping weights	Empty - 13,500 lbs. Filled with carbon - 27,500 lbs. (maximum) Spent - 32,500 lbs. (maximum) Spent and washed - 35,00 lbs. (maximum)
Temperature rating	150° F
Static pressure rating	0.5 psig
Vacuum pressure rating	None
Materials of construction	Vessels - Carbon steel Internals - Carbon steel Internal screen - Polypropylene Internal coating - Coal tar epoxy External coating - Coal tar epoxy Carbon acceptance canister - PVC
Air flow rate	Allowable range: 500 - 10,000 CFM
Internal cross-sectional area	30 ft^2
Carbon usage rate	About 200 lbs/day
Carbon regeneration frequency	About every two months (62.5 days actual) Six times per year

Treated air is monitored and emitted to the atmosphere.

C) Sludge Handling

1) Sludge Thickening Tank

Purpose: To temporarily hold the sludge and allow it to thicken so that dewatering is required about once per week.

Sludge Thickening Tank:

SLUDGE HOLDING TANK	
Volume	6,000 gallons
Diameter	12'1"
Height	11'9"
Wall thickness	1/4"
Material of construction	Carbon steel
Angle of cone	45°
Legs	symmetrically placed eight (8) legs
Additional fittings (tentative)	Ladder with cage for access to the top of tank, 24" access manhole on top and tank side, additional 150# conically gusseted flanged connections for process pipes, drainage lines, etc.
Total dry solids	About 138 lbs/day
Filter press operation frequency	Twice per week (estimated)
Thickened sludge volume/Total volume	0.6
Level control/alarm system	Interlocked with feed and transfer pumps - PLC controlled
Feed and transfer pumps	Air operated diaphragm pumps with timer - PLC controlled

SLUDGE HOLDING TANK	
Influent stream (from lamella gravity settler) solids concentration	About 1% by weight
Effluent stream (to filter press) solids concentration	About 3% by weight dry solids content

The overflow from the sludge thickening tank is allowed to flow by gravity to lift station # 3, from which it is pumped to the head of the treatment system. The thickened sludge is pumped from the can bottom to the filter press for dewatering using air operated diaphragm pumps.

2) **Sludge Dewatering**

Purpose: Reduction of water content in the metal hydroxide sludge before disposal using a recessed plate filter press. About 20 to 30 percent dry solids content should be achieved before disposal.

Filter Press:

FILTER PRESS	
Total dry solids	About 138 lbs/day
Filter press operation frequency	Twice every week
Filter press capacity	Required capacity - 19.8 ft^3 Provided capacity - 25 ft^3 (expandable to 30 ft^3)
Plate size	1000 mm square
Plates	Polypropylene, with caulking groove, gasketed, recessed
Cake thickness	1"

FILTER PRESS	
Number of chambers	39
Filter fabric	Polypropylene, rated at 4 CFM
Blinding plate	For partial loads
Expansion piece	For future plates
Operating temperature	105° F (maximum)
Dumpster	Self-dumping
Air blowdown	PVC piping
Flow configuration	Influent - center feed Effluent - four corner discharge
Plate shifter	Manual
Drip trays	Provided for containment of drippage from the press
Pressure rating	100 psi (variable), 7 bar
Corrosion control	Protective RAM boot
Roll-off Box Volume	25 ft^3
Legs extension	Provided for roll-off disposal system
Sludge volume for disposal	About 77 yd^3
Feed pumps	Air operated diaphragm type

Dewatered sludge is disposed off-site at a secure landfill. Filtrate is conveyed back to equalization tank #1 via lift station # 3.

3.2.3 Soil Vapor Extraction System

The main design criteria for the full-scale SVES is to reduce the level of organics in the soils at SWMU-11.

3.2.3.1 Description

The process and instrumentation (P&I) diagram for the full-scale SVES is presented in drawing I-10.

Groundwater and soil gas are extracted independently of each other from the SVES wells to optimize the overall system flexibility. This capability is necessary if the groundwater extraction system must continue to operate after the soil gas extraction system has been shut down. Soil gases extracted during the Stabilization Program are expected to be treated by a thermal/catalytic oxidation unit before being emitted to the atmosphere. Groundwater extracted during SWMU-11 stabilization is conveyed to the full-scale groundwater pretreatment system. Piping is enclosed in a 3-sided fence from the SVES to the groundwater pretreatment system.

3.2.3.2 Performance Standards

The following performance standards are used for measuring compliance with the design criteria:

- Discharge of treated air (i.e., soil gas) to comply with emission limits prescribed in an air discharge permit to be negotiated with RIDEM.

- Discharge of extracted groundwater to the groundwater pretreatment system is expected to be controlled by provisions of the Industrial Discharge Permit to be negotiated with the City of Cranston POTW.

- Soil gas extraction will continue until the concentration of VOCs in the extracted soil gas remains statistically flat (i.e., becomes asymptotic as determined by data regression) for six months, based on monthly soil gas quality analytical data.

- Groundwater extraction will continue until concentrations of VOCs in the extracted groundwater in each extraction well remain statistically flat (as determined by data regression) for four quarters based on quarterly groundwater quality monitoring analytical data.

3.2.3.3 Individual Units

The SVES uses a skid-mounted packaged vacuum system and other components to enhance the removal of groundwater from a well. The SVES is comprised of:

- Groundwater extraction wells
- Rotary-lobe type, positive-displacement vacuum pump system
- Vapor vacuum tank system
- Vapor extraction manifold
- Water extraction tank system
- Water discharge pumps
- Water extraction manifolds
- Interconnecting above-ground, insulated/heat traced pipe manifold system
- Vapor-phase treatment system
- SVES control system
- Equipment shelter (Trailer)

The SVES extracts groundwater and soil vapor in two separate streams from a well. Contaminated groundwater is hydraulically extracted through a straw in the well, while soil vapor is pneumatically extracted from unsaturated zone soils by applying vacuum directly to the well riser.

Groundwater Extraction Wells

The SVES is designed to extract a continuous minimum of 250 ACFM (188 SCFM) soil vapor at 8 inches Hg vacuum, and extract 5 GPM of contaminated groundwater from each extraction well. The wells are constructed or modified to have a 3-inch pipe, connected directly onto the well riser (casing) which is used to extract soil gases by applying vacuum, generated in an air vacuum tank, to the unsaturated zone soils.

Each well riser is fitted with a 0 to 30 inches Hg vacuum gauge to monitor the vacuum level applied to the well.

Each well has a 1-inch coaxial water extraction straw, adjusted to the desired water level in the well, and connected to a water extraction tank for groundwater extraction. An intrinsically-safe water level sensor/switch is installed in each well to provide a control signal to the water extraction manifold solenoid valve. This facilitates control of the water extraction rate and water level in the well.

The extraction wells are screened through the unsaturated zone into the saturated zone. These wells are able to extract contaminated groundwater and soil gas. Free-phase toluene product is not anticipated to be recovered. However, if recovered, the equalization tank is anticipated to reduce the concentration.

Vacuum Pump System

The vacuum pump on the SVES is a positive displacement rotary lobe type vacuum blower package (MD Pneumatics Model 5516 - 16/47 or equal). The pump package is capable of maintaining an effective minimum air flow of 1000 ACFM at a vacuum of 8 inches Hg (discharge to atmospheric pressure assumed), and a maximum temperature rise of 70°F. The vacuum pump is belt-driven and operated at its preferred rpm, with an oversized explosion-proof motor (1.5 service factor) to provide continuous, reliable and efficient pulse-free vacuum.

The vacuum pump skid includes a vacuum relief valve set at 10 inches Hg, an exhaust temperature and pressure gauge and high temperature and pressure shutoff switch. The system includes an inlet and exhaust silencer, and all piping which will exceed 120°F operating temperature is insulated.

Instrumentation on the vacuum pump skid includes the following:

- Inlet thermometer
- Inlet vacuum gauge
- Exhaust thermometer

- Exhaust pressure gauge
- Outlet flow measuring device (annubar differential pressure gauge)

Vapor Vacuum Tank System

The vacuum pump draws pneumatic suction on an 120 gallon vapor vacuum tank, which is connected to the vapor extraction manifold and the wells. The vapor vacuum tank has a water sensor in its bottom which provides a signal to transfer the accumulated water to the water extraction manifold.

Vapor Extraction Manifold

Soil gas extraction pipes from the wells connect to the vacuum system through a vapor extraction manifold. This manifold provides all of the connections, gauges and standard control valves required to control (ON/OFF and vacuum level balance) the air flow from each well. The vapor extraction manifold is fitted with an inlet particulate filter and a moisture coalescer element to knockout water droplets entrained in the air stream. The fittings for the vapor extraction manifold include the following:

- Dilution air valve (to allow dilution of the inlet vapor concentrations)
- Check valve (vacuum rated)
- Air control solenoid valve (normally closed)
- Air flow control/isolation valve (globe or gate valve)
- Vacuum gauge (0 to 30 inches Hg vacuum)
- Sight glass

Water Extraction Tank System

Contaminated groundwater is extracted from the straw in the well by the vacuum generated in the 120 gallon water extraction tank system. The vacuum level maintained in this tank is in considerable excess of that maintained in the vapor vacuum tank, sufficient to extract fluids hydraulically. The system includes a vacuum switch (set ON at 22 inches Hg and OFF at 25 inches Hg vacuum) to control the water discharge pumps, a high level water sensor to control the automatic operation of a small air purge vacuum pump (10 ACFM at 25 inches Hg) which removes excessive air from the tank top (i.e., during start-up and in the event that an air leak occurs), and two low water level sensors to shutdown one or both of the water discharge pumps in the event that the water level in the tank gets low (i.e., air has entered the system, or during start-up). During normal operation of the system, the pumps produce and maintain the operating water vacuum, which is moderated by a small air pocket at the tank top, and the air purge vacuum pump only removes excessive air as necessary.

Water Discharge Pumps

Progressive-cavity positive displacement pumps (Robbins and Myers Model 356 Motorized or equal) are used to transfer collected liquid from the water extraction tank to the groundwater pretreatment system, while creating and maintaining a vacuum (22 to 25 inches Hg) in the water extraction tank. Identical redundant pumps are used to provide automatic duty/backup service. The pumps are controlled to operate simultaneously and alternately, based on the low and low-low level sensors in the water extraction tank. The use of two pumps provides automatic backup operation in the event that the duty pump overloads or otherwise fails to operate. The pumps are capable of 16 GPM discharge against a combined 25 inches Hg suction and 20 PSI discharge pressure. The pumps are provided with oversized motors to provide a service factor of 1.5 of design capacity. The pumps are fitted with spring loaded check valves on the discharge connections and isolation ball valves on both the suction and discharge connections, a vacuum gauge (0-30 inches Hg vacuum) on the suction header, combination gauge (30 PSI-0-30 inches Hg vacuum) on the discharge header, and are fitted with a mag-meter type flow meter/totalizer, compatible with toluene and typical groundwater particulates and contaminants.

Air Purge Vacuum Pump

The water extraction tank high level water sensor automatically controls the operation of a small air purge oiless piston-type vacuum pump (25 inches Hg vacuum and 10 CFM open flow, Gast Model 5VDF or equal) which removes excessive air from the tank top (i.e., during start-up and in the event that an air leak occurs). During normal operation of the system, the vacuum is maintained by the water discharge pumps. The volume of the air pocket at the tank top, which expands under increased vacuum to moderate the vacuum level in the tank, is maintained by the air purge vacuum pump. Although the air purge vacuum pump is only intended to remove excessive air from the tank as necessary, it is rated for continuous, heavy duty and frequent start-stop service. The oversized explosion-proof motor provides a service factor of 2.0.

Water Extraction Manifold

The straw from each well is connected to the water extraction tank through the water extraction manifold. The water extraction manifold controls water flow from each well. Each connection to the manifold consists of a check valve, a vacuum service (water) solenoid valve, a flow-control gate or globe valve, a vacuum gage and a sight glass.

Interconnecting above-ground, Pipe Manifold System

The piping between the extraction wells and the equipment trailer is installed 2-feet above grade on suitably spaced pipe rack supports (Uni-strut or equal). To accommodate this arrangement while providing maximum protection (freeze and impact) to the water extraction piping, the 1-inch schedule 80 PVC water extraction piping is run within the 3-inch schedule 40 carbon steel vapor extraction pipe (no centralizers). The water extraction piping has threaded and socket welded fittings to accommodate pipe installation and disassembly. Vapor extraction piping has welded 125-lb class flanged fittings, and transitions to schedule 80 PVC within the equipment shelter. All piping is provided with flexible joints at the equipment trailer. WHAT ABOUT H_2O IN THE VAPOR EXTRACTION PIPE ?

All exposed piping is heat traced and insulated to prevent freezing and frosting conditions.

SAFETY CHECKS DURING WINTER OPERATION

Vapor-phase Treatment System

As required to meet vapor-phase discharge requirements, a thermal/catalytic oxidizer vapor phase treatment system (with exhaust heat exchanger to preheat the inlet air) is installed to reduce the effluent contamination levels to the necessary limits. This device is set up to operate using natural gas, and is capable of handling 1000 ACFM inlet air. The unit is designed for ready changeover from thermal oxidation (LEL 80 percent maximum inlet concentration) to catalytic oxidation (LEL 25-30 percent inlet concentration), as the combustible vapor concentrations decrease with time. This system is fitted with an automatic dilution air valve controlled by a temperature sensor in the exhaust stack and a shutdown temperature sensor (maximum not to exceed exhaust temp).

SVES Control System

A suitable NEMA rated control panel with circuit-breaker disconnect, control transformer, motor starters, controls and indicators provides automatic and manual control of the complete system. The short-circuit protection and disconnecting device is a three-pole circuit breaker. The motor starters are across-the-line full voltage, non-reversing, magnetic starters with three ambient compensated overloads. The control circuit has an individual 120 volt fused secondary, grounded control power transformer and external reset buttons, start/stop buttons, and pilot lights.

Table ~~3-2~~ 3-1
Proposed Performance Standards
Stabilization Action - Cranston, Rhode Island
Groundwater Pretreatment System
Aqueous-Phase Treatment

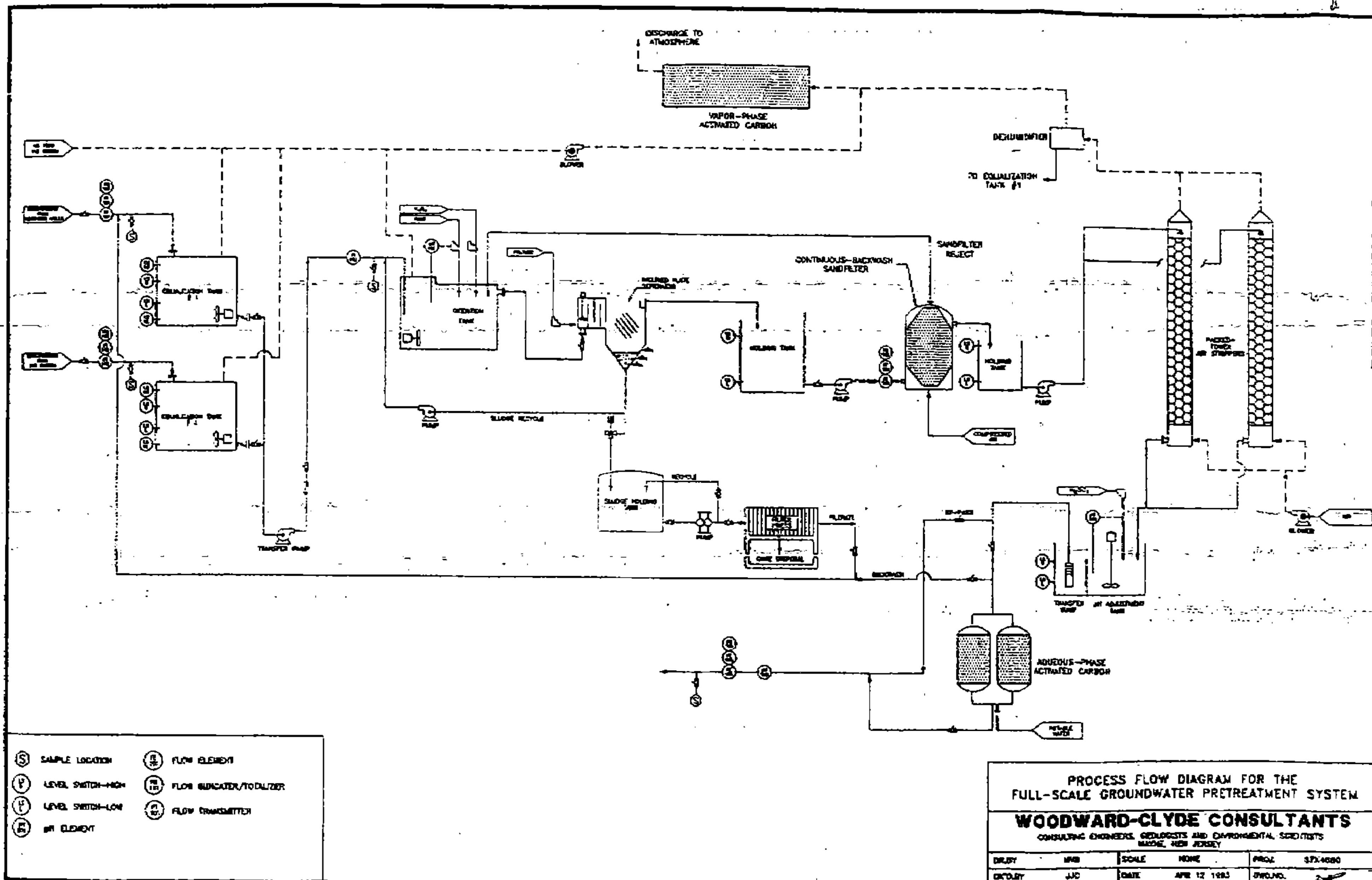
Parameter	Effluent Concentration (mg/l)
Antimony (total)	0.05
Arsenic (total)	0.1
Beryllium (total)	0.005
Boron (total)	1.0
Cadmium (total)	0.04
Chromium (total)	0.4
Copper (total)	1.0
Cyanide (total)	0.3
Iron (total)	2.0
Lead (total)	0.3
Manganese (total)	2.0
Mercury (total)	0.005
Nickel (total)	0.7
Phenols (total)	1.0
Selenium (total)	0.01
Silver (total)	0.1
Thallium (total)	0.005
Zinc (total)	1.0
Total Toxic Organics	2.13
Oil and Grease	25 Mineral/Petroleum Origin 100 Animal/Vegetable Origin
pH	5.5 to 9.5 units

Table ~~13~~ 3-2
Proposed Performance Standards
Stabilization Action - Cranston, Rhode Island
Groundwater Pretreatment System
Vapor-Phase Treatment

Parameter	Maximum Emission Rate (lb/hr)
Acrylonitrile	0.004
Aniline	0.04
O-Anisidine	0.001
Antimony & Antimony Compounds	1.14
Arsenic & Arsenic Compounds	0.0
Benzene	0.005
Benzidine	0.0
Benzotrichloride	0.0
Benzyl Chloride	0.005
Cadmium & Cadmium Compounds	0.0
Carbon Tetrachloride	0.001
Chloroform	0.002
Chromium & Chromium Compounds	0.0
3,3'-dichlorobenzidine	0.0001
Dioctyl Phthalate	0.03
Diphenyl	0.02
Diphenyl Amine	1.14
Epichlorohydrin	0.04
Ethylene Dichloride	0.002
Ethylene Oxide	0.0005
Hydrazine	0.0
Hydrogen Chloride	1.14
Hydrogen Fluoride	0.1
Lead	1.14
Manganese & Manganese Compounds	0.01

Table ~~3.3~~ 3-2
Proposed Performance Standards
Stabilization Action - Cranston, Rhode Island
Groundwater Pretreatment System
Vapor-Phase Treatment

Parameter	**Maximum Emission Rate (lb/hr)**
Methyl Cellosolve	1.14
Methylene Biphenyl Iscyante (MDI)	0.003
4,4'-Methylene bis(2-chloroaniliine)	0.05
Methylene Chloride	0.01
Nickel & Nickel Compounds	0.0001
5-Nitro (o-anisidine)	0.004
2-Nitropropane	0.01
Perchloroethylene	0.002
Styrene	1.14
Toluene	1.14
Toluene-2,4 Diisocyanate (TDI)	0.001
O-Toluidene	0.002
1,1,2 Trichloroethane	0.3
Trichloroethylene	0.02
Triethylamine	1.14
Xylene	1.14
Other Contaminants	10


DISCHARGE TO ATMOSPHERE
VAPOR-PHASE ACTIVATED CARBON
BLOWER
DEHUMIDIFIER
TO EQUALIZATION TANK #1
EQUALIZATION TANK #1
EQUALIZATION TANK #2
OXIDATION TANK
INCLINED PLATE SEPARATOR
HOLDING TANK
CONTINUOUS-BACKWASH SANDFILTER
SANDFILTER REJECT
HOLDING TANK
PACKED-TOWER AIR STRIPPERS
PUMP
SLUDGE RECYCLE
COMPRESSED AIR
SLUDGE HOLDING TANK
RECYCLE
FILTRATE
CAKE DISPOSAL
TRANSFER PUMP
BACKWASH
BY-PASS
TRANSFER TANK
pH ADJUSTMENT TANK
AQUEOUS-PHASE ACTIVATED CARBON
POTABLE WATER
SAMPLE LOCATION
LEVEL SWITCH-HIGH
LEVEL SWITCH-LOW
pH ELEMENT
FLOW ELEMENT
FLOW INDICATER/TOTALIZER
FLOW TRANSMITTER
PROCESS FLOW DIAGRAM FOR THE
FULL-SCALE GROUNDWATER PRETREATMENT SYSTEM
WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS
SCALE NONE
CHK'D BY JJC
DATE APR 12 1993
DWG.NO.

3-2

SECTION 4

4.1 OVERVIEW

The purpose of this section is to provide a written description of the systems, unit processes, controlled/monitored parameters, system interlocks and alarm conditions associated with the facility. The functional description is intended to be used in conjunction with the process and instrumentation diagrams (P&IDs) developed for the groundwater capture and pretreatment systems and SVES.

4.2 FUNCTIONAL DESCRIPTIONS

Functional descriptions are presented for the following three systems (and their associated unit processes):

- Groundwater Capture System;
- Groundwater Pretreatment System; and
- SVES.

A typical functional description includes the following information:

- Description of the Unit Process;
- Parameters Controlled;
- Parameters Monitored;
- System Interlocks; and
- Alarms Conditions.

4.2.1 Groundwater Capture System

The main design criteria for the groundwater capture system is to reverse the hydraulic gradient at the bulkhead (along the Pawtuxet River) by maintaining a drawdown of up to two-feet. Groundwater is pumped from at least two recovery wells in the Production Area. The groundwater is conveyed via an above-grade forcemain to the groundwater pretreatment system. To ensure that the required hydraulic gradient reversal is maintained, water levels in selected in-river and Production Area monitoring wells/piezometers are monitored. The static water level in the in-river monitoring wells (located on the river side of the bulkhead) is compared to the corresponding Production Area wells to determine if the gradient is reversed. A differential static water level of up to two-feet is maintained (when possible) automatically between the in-river well and its corresponding Production Area monitoring well/piezometer by adjusting the flowrate from each recovery well.

One compact programmable logic controller (PLC) is installed with each recovery well to control the pumping rate and monitor drawdown. The recovery well PLCs are linked to the main PLC located in the control room of Building No. 15. The recovery well PLC, motor-starter, instrumentation, and associated piping/valves are housed in a small pre-engineered structure around the well. The discharge from each recovery well is conveyed to a common header and forcemain to the groundwater pretreatment system. As noted above, at least two recovery wells are used in the groundwater capture system design. Since all of the recovery wells are identical (with the exception of flowrate), the functional description for a typical recovery well is presented here:

Parameters Monitored
The groundwater capture system monitors the following parameters:

- Discharge pressure.
- Static-water level in the in-river well.
- Static-water level in the Production Area monitoring well/piezometer.
- Differential level between the in-river well and its associated Production Area monitoring well/piezometer.
- Instantaneous flow from each recovery well.
- Total flow from each recovery well.
- Discharge pressure from each recovery well.
- Run-time of each recovery well pump.
- Position of the local hand-off-auto (HOA) switch for the recovery well pump.
- Pump motor overload.

Parameters Controlled

The groundwater capture system controls the following parameters:

- Flow from each recovery well is varied through the flow control valve depending on the differential water level between the in-river monitoring well and the associated Production Area monitoring well/piezometer. Flow from each recovery well is increased or decreased as required to maintain the required drawdown at the bulkhead.

System Interlocks

The following groundwater capture system signals require to be interlocked:

- A low level signal in the recovery well level element stops the recovery well pump to prevent it from running dry.
- A high-high level signal from the level element in Equalization Tank No. 1 stops all recovery well pumps to prevent the equalization tank from overflowing. The pumps will not restart automatically once the normal operating level in the equalization tank is obtained. A manual restart will be required.

Alarm Conditions

The following groundwater capture system alarms are "logged" for each recovery well:

- Low level in the recovery well.
- Low flow in the discharge line.
- Low pressure in the recovery well discharge line.
- High pressure in the recovery well discharge line.
- Pump motor overload.

4.2.2 Groundwater Pretreatment System

The groundwater pretreatment system is designed to remove dissolved metals and VOCs prior to discharge to the Cranston, Rhode Island, POTW. The groundwater pretreatment system consists of the following three components:

A. Aqueous-Phase Treatment;
B. Vapor-Phase Treatment; and
C. Sludge Handling/Dewatering.

Operational descriptions for each of the above components are provided below.

A. AQUEOUS-PHASE TREATMENT

A.1 Equalization

Equalization is provided to minimize the fluctuations in groundwater flow and contaminant loading to the pretreatment system. Two equalization tanks are provided in the stabilization action. Equalization Tank No. 1 is provided for the groundwater extracted from the groundwater recovery system while Equalization Tank No. 2 is provided for the groundwater extracted by the SVES. Agitators are provided in both tanks to ensure a "complete-mix" scenario.

The functional descriptions for both equalization tanks are similar and are presented here:

Parameters Monitored
The following parameters are monitored:

- Level - continuous.
- Run-time of the agitator motor.
- Position of the HOA switch for the agitator.
- Pressures in the discharge lines of the transfer pumps.
- Run-time of the transfer pump motors.
- Position of the HOA switches provided for the transfer pumps.
- Position of the A/B selector for the transfer pumps (Equalization Tank No. 1 only).
- Continuous flow from the equalization tanks to the oxidation tanks.
- Total flow from the equalization tanks to the oxidation tanks.

Parameters Controlled

The following parameters are controlled:

- Groundwater flow from Equalization Tank No. 2 to the pretreatment system will be controlled by the in-line organic analyzer. Groundwater flow from Equalization Tank No. 2 will be decreased when the organic concentration of the groundwater is not with in acceptable range.
- Rotation of transfer pump "A" or "B" (Equalization Tank No. 1 only).

System Interlocks

The following signals are interlocked:

- A low level signal from the level element in the equalization tank (either tank no. 1 or 2) stops the operation of the transfer pumps.
- A high level signal from the level element in the Equalization Tank No. 1 starts the transfer pumps.
- A high-high level signal from the level element in either equalization tank stops the operation of the associated recovery well pumps/transfer pumps.
- A high-high level signal from the level switch in the inclined plate separator stops the operation of the equalization tank transfer pumps.
- A high level signal from Lift Station No. 1 stops the flow from the equalization tank transfer pumps.
- A high pressure signal from the transfer pump discharge stops the transfer pumps.
- A low air flow signal from the sand filter stops operation of the equalization tank transfer pumps.

Alarm Conditions

The following alarm conditions are logged by the system:

- Low-low level in Equalization Tank No. 1 or 2.
- High-high level in Equalization Tank No. 1 or 2.
- High-pressure in the discharge lines of the equalization tank transfer pumps.

- High level in Equalization Tank No. 1 or 2.
- Low level in Equalization Tank No. 1 or 2.
- Pump motor overload.

A.2 Air Oxidation System

Equalized groundwater is pumped to the oxidation/pH adjustment reactors. Dissolved ferrous iron present in the groundwater is oxidized with air to the less soluble form of ferric iron. As the oxidation occurs, the pH of the groundwater drops slightly as a result of hydrogen ion production. Adjustment of the groundwater pH with a 20 percent solution of sodium hydroxide (NaOH) is employed. A low-pressure centrifugal blower provides the required air supply.

A chemical oxidation system using 35 percent hydrogen peroxide (H_2O_2) is provided as a back-up should air oxidation be unable to facilitate the complete oxidation of the dissolved iron and manganese in the groundwater. A hydraulic retention time (HRT) of about thirty minutes is provided to ensure sufficient time for oxidation and pH adjustment to occur.

Parameters Monitored

The following parameters are monitored:

- pH - Continuous.
- Run-time of the NaOH feed pump.
- Position of the HOA switch for the NaOH feed pump.
- Run-time of the H_2O_2 feed pump.
- Position of the HOA switch for the H_2O_2 feed pump.
- Run-time of the low pressure air blower.
- Position of the ON/OFF switch for the blower.
- Run-time of the agitator.
- Position of the ON/OFF switch for the agitator.
- Air flow from the low pressure blower.

Parameters Controlled
The following parameter is controlled:

- pH in the oxidation tank.

System Interlocks
The following signals are interlocked:

- A low pH signal from the pH analyzer are interlocked with the NaOH feed pump to start the addition of NaOH.
- A high pH signal from the pH analyzer are interlocked with the NaOH feed pumps to stop the addition of NaOH.
- No flow indication from the flow switch in the low pressure blower starts the addition of H_2O_2.
- A low-low level signal from the NaOH or H_2O_2 tote will stop the groundwater transfer pumps.
- Agitator motor overload stops H_2O_2 and NaOH pumps.

Alarm Conditions
The following alarms are logged by the system:

- Low pH in the oxidation tank.
- High pH in the oxidation tank.
- No flow from the low-pressure blower.
- Low NaOH or H_2O_2 level.
- Low-low NaOH or H_2O_2 level.
- Pump motor/agitator overload.

A.3 Deaeration/pH Adjustment Tank

A deaeration stage is provided to allow air bubbles potentially entrained in the metal hydroxide precipitation produced during air oxidation to be released, thus improving sludge settling. A separate control system is provided in this tank to adjust the groundwater's pH, if required. Sodium hydroxide is used in this reactor also, if required. An HRT of about thirty minutes is provided in the deaeration/pH adjustment tank.

Parameters Monitored

The following parameters are monitored:

- pH - Continuous
- Run-time of the NaOH feed pump
- Position of the HOA switch for the NaOH feed pump motor
- Run-time of the tank agitator
- Position of the ON/OFF switch for the agitator

Parameters Controlled

The following parameter is controlled:

- pH

System Interlocks

The following signals are interlocked:

- A low pH signal from the pH analyzer is interlocked with the NaOH feed pump to start the addition of NaOH .
- A high pH signal from the pH analyzer is interlocked to stop the addition of NaOH.
- Agitator motor overload stops the addition of NaOH.

Alarm Conditions

The following alarms are logged by the system:

- Low pH in the deaeration/pH adjustment tank.
- High pH in the deaeration/pH adjustment tank.
- Low NaOH level in chemical tote.
- Motor overload trips.

A.4 Flocculation/Clarification

An inclined-plate separator is provided to remove the metal hydroxide precipitates formed during air-oxidation and pH adjustments. A flash mixing zone, flocculation zone, and gravity settling zone is provided in the plate separator. High molecular weight anionic polymer is added to the flash-mix zone of the separator to enhance flocculation. The insoluble metal hydroxide flocs form in the flocculation zone and settle to the bottom of the separator's internal sludge thickener. Excess sludge is transferred to the sludge thickening tank. A portion of the settled sludge is pumped to the oxidation tanks to enhance floc formation. The supernatant from the separator exits from the top of the unit and flows by gravity to the sand filter.

Parameters Monitored

The following parameters are monitored:

- Run-time of the flash-mixing zone agitator.
- Position of the local ON/OFF switch for the flash mixing zone agitator.
- Run-time of the flocculation-zone mixer.
- Positions of the local ON/OFF switch for the flocculation zone mixer.
- Run-time of the polymer feed pump.
- Position of the HOA switch for the polymer feed pump.
- Pressure in the sludge recycle line.
- Pressure in the sludge transfer line.

Parameters Controlled

The following parameters are controlled:

- Start/stop operation of the sludge transfer and sludge recycle pumps is controlled by a time cycle.
- Operation of the polymer addition system is proportional to the groundwater feed rate from the equalization tanks.

System Interlocks

The following signals are interlocked:

- A high pressure signal from the pressure transmitter on sludge transfer line stops the sludge transfer pump.
- A high pressure signal from the pressure transmitter on sludge recycle line stops the sludge recycle pump.
- A high-high level signal from the level switch in the top of the inclined plate separator stops the groundwater transfer pumps from Equalization Tank No. 1 and 2.
- A low flow from the Equalization Tank No. 1 flow transmitter stops the polymer addition system.
- Agitator motor trip stops the polymer addition system.

Alarm Conditions
The following alarms is logged by the system:

- High pressure in the sludge transfer line.
- High pressure in the sludge recycle line.
- High-high level in the inclined separator.
- Agitator motor trips.

A.5 Sand Filtration

An existing Parkson Dynasand™ filter removes any residual suspended solids in the overflow from the inclined-plate separator prior to air stripping. As the groundwater flows upwards through the sand bed, residual suspended solid particles are trapped by the media. A compressed air source provides a continuous air scour supply provides an air lift to the top of the unit where the solids are physically separated from the sand. The reject (backwash) water generated during the filtering operation (5 to 7 percent of the total flow) flows by gravity to Lift Station No. 3 were it is pumped to Equalization Tank No. 1.

Parameters Monitored
The following parameters are monitored:

- Air flow from the compressed air supply.

Parameters Controlled

No parameters are controlled at this location.

System Interlocks

The following signals are interlocked:

- A no flow signal from the flow indictor on the compressed air line to the sand filter stops the transfer pumps at Equalization Tanks No. 1 and 2.

Alarm Conditions

The following alarms are logged by the system:

- No compressed air flow.

A.6 Intermediate Lift Stations

Three (3) intermediate lift stations are required to convey the groundwater through the pretreatment system. All three lift stations consist of a wet-well and two transfer pumps. An HRT of about 15 minutes is provided in the lift station's wet-well to minimize the amount of pump start cycles. The functional descriptions for all three lift stations similar. Control of Lift Stations No. 2 and 3 will be based on level in the wet-well. An agitator is added to Lift Station No. 3 to prevent the settling of suspended solids.

Parameters Monitored

The following parameters are monitored in all three lift stations:

- Continuous level in the wet-well.
- Run-time of the agitator motor (Lift Station No. 3 only).
- Positions of the ON/OFF switch for the agitator motor (Lift Station No. 3 only).
- Pressure in the discharge line.
- Run-time of the transfer pumps.
- Position of the HOA switches for the transfer pumps.
- Transfer pump discharge valve position.

Parameters Controlled

The following parameters are controlled in Lift Station No. 1 only.

- Flow from Lift Station No. 1 is controlled by the in-line organic analyzer. Flow is decreased when the organic concentration of the groundwater is not in the acceptable range.

System Interlocks

The following signals are interlocked:

- A low-low level signal from the level element in the wet-well is interlocked with the transfer pumps to stop their operation.
- A high-high level signal from the level element in the wet-well is interlocked with the other transfer pumps in the pretreatment system to stop their operation so that the tank does not overflow.
- High level signal from the level transmitter in the wet-well is interlocked to start the transfer pumps.
- High pressure signal from transfer pumps discharge stops the transfer pumps.
- A high-high concentration from the organic analyzer will stop the transfer pumps.

Alarm Conditions

The following alarms are logged for each lift station by the system:

- High-high level in the lift station wet-well.
- Motor overload trips.

A.7 Air Stripping

An existing down-flow countercurrent air stripper removes VOCs from the groundwater. Air for the stripper is supplied by a separate low-pressure high-volume blower. Groundwater is pumped to the unit via Lift Station No. 1. An in-line organic analyzer is provided to control the flow to the stripper from the lift station. As organic concentrations increase, flow to the stripper is reduced, thus increasing the effective air-to-water ratio of the unit. Differential pressure in the stripper is monitored to indicate possible fouling of the unit.

Parameters Monitored

The following parameters are monitored:

- Organic concentration in the groundwater by the in-line organic analyzer.
- Pressure differential in the stripper's air supply line.
- Run-time of the low-pressure blower.
- Position of the local ON/OFF switch for the blower.
- Flow conditions from the low-pressure blower.

Parameters Controlled

The following parameters are controlled:

- Groundwater flow to the air stripper is either increased or decreased depending on the organic concentration from the in-line organic analyzer.

System Interlocks

The following signals are interlocked:

- The organic concentration signal from the in-line organic analyzer is interlocked with the automatic control valve on Lift Station No. 1. As organic concentration in the groundwater increase, flow to air stripper decreases.
- A no-flow signal from the low-pressure blower will shut down the transfer pumps.

Alarm Conditions

The following alarms are logged by the system:

- No air flow from the low-pressure blower.
- High organic concentration in the influent.

A.8 Aqueous-Phase Activated Carbon

Following air stripping, aqueous phase activated carbon is provided to remove any residual organic compounds prior to discharge. Two (2) activated carbon vessels are provided. The vessels can be operated in either parallel or series. The aqueous-phase activated carbon system is provided with a backwashing system. Backwashing operations are initiated manually but are conducted automatically. Backwashing is performed on a regular schedule, about once per week. During backwashing, the carbon bed is expanded with City water for a period of about 20 minutes. Water from backwashing operations will be conveyed to Equalization Tank No. 1 by gravity. The carbon units are operated in series and samples are collected manually between the two units to determine breakthrough. When the capacity of the "lead" carbon unit has been exhausted, carbon exchange is scheduled.

See PG 3-2?

Parameters Monitored

The following parameters are monitored:

- Position of the A/B selector switch for the operational configuration of carbon absorbers.
- Operation and sequence of the backwash cycle.
- Adsorption capacity (manual sampling).
- Position of the bypass valve.
- Position of internal valves.

Parameters Controlled

The following parameters are controlled:

- Backwashing operations (manually initiated).

System Interlocks

No signals from the carbon is interlocked with the system at this time.

Alarm Conditions

The following alarm conditions are logged by the system:

- Unauthorized opening/closing of the carbon bypass valve.

A.9 Final pH Adjustment

A final pH control system is provided to adjust the pH of the treated groundwater (to within the permitted range) before being discharged to the sanitary sewer. If required, 93 percent sulfuric acid (H_2SO_4) is used at this location to reduce the pH of the groundwater. An HRT of about 20 minutes is provided in the pH adjustment tank.

Parameters Monitored

The following parameters are monitored:

- Level - continuous.
- Continuous effluent flow.
- Total effluent flow.
- Final effluent pH.
- Run-time of the H_2SO_4 feed pump.
- Position of the HOA switch for the H_2SO_4 feed pump.
- Run-time of the agitator.
- Position of the ON/OFF switch for the agitator motor.

Parameters Controlled

The following parameters are controlled:

- Final effluent pH.

System Interlocks

The following signals are interlocked:

- A high pH signal from the final pH analyzer to stop the operation of the transfer pumps at Equalization Tanks No. 1 and 2.

- A low pH signal from the final pH analyzer to start the operation of the transfer pumps at Equalization Tanks No. 1 and 2.
- A high-high level signal from the level element in the final pH adjustment tank is interlocked with the Lift Station No. 2 transfer pumps to stop their operation.
- Agitator motor trip to be interlocked to stop H_2SO_4 pump.

Alarm Conditions
The following alarms are logged by the system:

- High effluent pH.
- Low effluent pH.
- High-high level in the final pH adjustment tank.
- Agitator motor trip.

B. VAPOR-PHASE TREATMENT

B.1 Vapor-Phase Activated Carbon

The vapor discharged from the air stripper and several process tanks in the pretreatment system is treated using vapor-phase activated carbon. A dehumidifier is provided prior to the carbon unit to reduce the moisture content of the vapors. Equipment and space for two (2) vapor-phase carbon units are provided, however, only one unit is in operation at any time. Once treated, the air stream is discharged to the atmosphere.

Parameters Monitored
The following parameters are monitored:

- Flow from the low-pressure blower.
- Run-time of the low-pressure air blower.
- Position of the local ON/OFF switch for the blower motor.
- Differential pressure through the carbon bed on the air supply line.
- Adsorption capacity of the carbon (manually sampled).
- Relative humidity of the vapor stream.

- Temperature in the dehumidifier.

Parameters Controlled

The following parameters are controlled:

- Temperature in the dehumidifier.

System Interlocks

- No air flow signal from the blower shuts down the dehumidifier.

Alarm Conditions

The following alarms are logged by the system:

- Low-temperature in the dehumidifier.

C. SLUDGE HANDLING/DEWATERING SYSTEM

C.1 Sludge Thickening Tank

A sludge thickening tank is provided to reduce the number of sludge dewatering operations per week. The sludge tank has a 45° cone bottom to allow the sludge to thicken before being pumped to the filter press. The supernatant from the tank is conveyed by gravity to Lift Station No. 3.

Parameters Monitored

The following parameters are monitored:

- Pressure in the discharge line of the sludge transfer pump.

Parameters Controlled

The following parameters are controlled:

- Transfer of sludge to the sludge holding tank is controlled by the level of sludge in the inclined plate separator.

System Interlocks
Signals from this location are not interlocked with the system.

Alarm Conditions
The following alarms are logged by the system:

- A high pressure signal from the pressure switch in the sludge transfer line is interlocked with the sludge transfer pump to stop its operation.

C.2 Filter Press

Sludge generated during groundwater pretreatment is dewatered using a recessed plate filter press. The sludge is dewatered to a dry solids concentration of about 20 to 30 percent by weight. The sludge cake is disposed of off-site. All sludge dewatering operations are initiated manually and then allowed to proceed automatically. Filtrate from dewatering operations flows by gravity to Lift Station No. 3.

Parameters Monitored
The following parameters are monitored:

- Filter press pressure.
- Sequence of filter press operations.
- Filtrate flow from the filter press.

Parameters Controlled
The following parameters are controlled:

- Sequence of operations during filter press use.
- Duration/pressure of sludge pumping cycle to the press is controlled by a 3-step pressure regulator on the filter press.

System Interlocks

The following signals are interlocked:

- A low filtrate flow signal from the filter press is interlocked with the sludge transfer pump to stop sludge dewatering operations.

Alarm Conditions

The following alarms are logged by the system:

- Low pressure in the air supply source to the sludge transfer pump.

4.2.3 Soil Vapor Extraction System

The main SVES panel provides control for all the major SVES components. The PLC for the SVES is integrated with the main PLC located in Building No. 15. The SVES's equipment is installed in a trailer located near SWMU-11. The trailer is partitioned into two zones: explosion-proof and non-hazardous. A sealed partition wall and forced air ventilation system is provided to separate the two zones. The SVES consists of two major components:

A. Water/Vapor Extraction System
B. Thermal/Catalytic Oxidizer

The thermal oxidizer is to be located outside the SVE System trailer.

A. WATER/VAPOR EXTRACTION SYSTEM

A.1 Extraction Wells

Seven (7) extraction wells are used for the SVE System. The four dual-phase (water and vapor) wells are operated independently to extract groundwater and soil vapor from the subsurface. Three additional wells will pump groundwater only. Soil vapor is extracted directly from a connection to the well riser, while groundwater is extracted from each well through a coaxial straw, which extends into the well below the static groundwater level. Each extraction well is connected to the water and vapor extraction manifolds. A liquid level sensor is used to control automatically the water and vapor extraction manifold solenoid valves.

Parameters Monitored

The following parameters are monitored:

- Water-level in each extraction well.
- Vacuum pressure from each extraction well casing.
- Vacuum pressure from each water extraction straw.

Parameters Controlled

The following parameters are controlled:

- Water flowrate from each extraction well.
- Vapor flowrate from each extraction well.

System Interlocks

The following signals are interlocked:

- A low-low level signal from the level element in the extraction well to stop extraction of water from the well.
- A low level signal from the level element in the extraction well to start the extraction of vapor.
- A high level signal from the level element in the extraction well to start the extraction of water.
- A high-high level signal from the level element in the extraction well to stop the extraction of vapor from the well.
- A high-high level signal from Equalization Tank No. 2 to stop the extraction of water and vapor from the wells.

Alarm Conditions

The following alarms are logged by the system:

- High-high level in the vapor extraction tank.

A.2 Vapor Extraction Tank System

A positive-displacement, lobe-type vacuum blower is used to extract soil vapor from the extraction wells and transfer it to the thermal oxidizer. The vapor extraction tank provides a pneumatic vacuum reservoir for the vapor and also functions as a knockout/receiver tank for removal of water droplets, condensate and particulates which may be entrained in the incoming vapor. Liquid-level sensors in the vapor extraction tank automatically control the discharge of accumulated water in the tank and shut down the vacuum blower in the event of a high-high water level condition.

Parameters Monitored
The following parameters are monitored:

- Pressure in the vapor extraction tank.
- Run-time of the positive-displacement blower.
- Position of the HOA switch for the blower.
- Water Level - Continuous in the vapor extraction tank.
- Vapor flowrate.

Parameters Controlled
The following parameters are controlled:

- Water level in the knockout/receiver tank is controlled by the level element located in the tank.

System Interlocks
The following signals are interlocked:

- A high inlet vacuum signal from the pressure transmitter is interlocked with the vacuum blower to stop operation.
- A high discharge pressure signal from the pressure transmitter is interlocked with the vacuum blower to stop operation.

- A high-high level signal from the level element in the vapor extraction/knockout tank is interlocked with the vacuum blower to stop operation.

Alarm Conditions
The following alarms are logged by the system:

- High vacuum blower inlet pressure.
- High blower discharge pressure.
- High vapor discharge temperature.
- High-high level in the vapor extraction tank.

A.3 Water Extraction Tank System

Duplex progressive-cavity (positive-displacement) pumps are used to extract groundwater from the extraction wells. Extracted groundwater is pumped to the Equalization Tank No. 2. The groundwater extraction pumps are controlled by the vacuum pressure sensor on the water extraction tank and are interlocked with the water extraction tank low-low level switch, which prevents the pump from running dry. The high-high level switch in Equalization Tank No. 2 shuts down the pumps to prevent the equalization tank from overflowing.

Parameters Monitored
The following parameters are monitored:

- Vacuum pressure in the water extraction tank.
- Run-time of the progressive-cavity pumps.
- Position of the HOA switch for the pump.
- Level in the water extraction tank.
- Total water flow to Equalization Tank No. 2.
- Instantaneous flow to Equalization Tank No. 2.
- Position of the A/B selector switch for the pumps.

Parameters Controlled

The following parameters are controlled.

- Vacuum pressure in the water extraction tank.
- Operation of pump "A" or "B".

System Interlocks
The following signals are interlocked:

- A low-low level signal from the level element in the water extraction tank is interlocked with the water extraction pumps to stop their operation.
- A high-high level signal from the level element in Equalization Tank No. 2 is interlocked with the water extraction pumps to stop their operation.

Alarm Conditions
The following alarms are logged by the system:

- Low-low level in the water extraction tank.
- High-high level in Equalization Tank No. 2.

B. THERMAL/CATALYTIC OXIDIZER

B.1 Thermal/Catalytic Oxidizer

The thermal/catalytic oxidizer is installed outside and adjacent to the equipment trailer for the SVES. The control panel for the oxidizer has an air purge system which prevents the system from being operated until the panel interior has been suitably purged. Operation of the oxidizer is a prerequisite for the operation of the SVES. A shut-down condition at the oxidizer results in a shut-down of the SVES. The thermal oxidizer is supplied with its own control panel which is interlocked with the SVES control system. The oxidizer must reach an operating temperature of 140^{0}F before the SVES is able to start-up.

Parameters Monitored
The following parameters are monitored:

- Temperature in the oxidizer.
- Air-flow to the oxidizer.
- Run-time of the oxidizer.
- Position of the HOA switch for the oxidizer.

Parameters Controlled
The following parameters are controlled:

- The internal temperature of the oxidizer is controlled by an internally mounted temperature probe.

System Interlocks
The following signals are interlocked:

- A temperature signal from the temperature probe is interlocked with the SVES and make-up air blower. A signal of at least 140^{0}F is required to start the operation of the SVES. A high temperature signal is interlocked with the make-up air blower to increase the amount of air to the combustion chamber.

Alarm Conditions
The following alarms are logged by the system:

- High temperature in the combustion chamber.
- Low gas supply pressure.
- High gas supply pressure.
- Power interruption.
- Flame failure.
- Make-up air supply failure.

SUMMARY

Functional descriptions are provided for the major stabilization action components. The functional descriptions are to be used in conjunction with the P&IDs developed for the stabilization action in Cranston, Rhode Island. The functional descriptions are not to be used as a stand-alone document to describe the stabilization action unit processes or control system.

SECTION 5

5.0
SYSTEM OPERATION

5.1 OVERVIEW

This chapter presents the standard operating procedures (SOPs) for the groundwater capture and pretreatment system and SVES. The following SOPs are provided for each system:

- Pre-startup procedures;
- Startup procedures;
- Normal operations;
- Shutdown procedures;
- Emergency shutdown procedures; and
- System monitoring procedures.

At this time, these procedures cannot be prepared. After system design and equipment procurement is complete, these procedures will be written and confirmed during system startup.

SECTION 6

6.0
MAINTENANCE AND REPAIR

This section presents the maintenance procedures for:

- Routine inspection;
- Preventative maintenance; and
- Preparation for maintenance.

In addition, specific maintenance procedures for equipment lock out/tag out and confined space entry are provided also.

At this time, these procedures cannot be prepared. After system design and equipment procurement is completed, these procedures will be prepared.

SECTION 7

7.0
POTENTIAL OPERATING PROBLEMS

At this time, potential operating problems cannot be identified. After system design and equipment procurement is completed, these procedures will be developed to resolve these problems.

SECTION 8

8.0 SAMPLING/LABORATORY TESTING PROTOCOL

The sampling and laboratory protocol used will be based on the requirements of the water and air discharge permits.

At this time, these procedures cannot be prepared. After system design and equipment procurement is completed and permits are obtained, these procedures will be prepared.

SECTION 9

9.1 OVERVIEW

This section summarizes the estimated Operation and Maintenance (O&M) costs, on an annual basis, for the groundwater capture and pretreatment system and SVES.

These estimates cannot be finalized until equipment procurement is completed. Table 9-1 presents the initial estimates.

TABLE 9-1

ANNUAL OPERATING AND MAINTENANCE COSTS

	COST COMPONENT	COST ESTIMATE ($/yr)
1	**Operating Labor**	
	Direct Operating Labor	$30,000
	Labor Supervision	$6,000
	Total Operating Labor	$36,000
2	**General Supplies**	
3	**Fuel**	$20,000
4	**Water**	$26,158
5	**Chemicals**	$40,000
6	**Electric Power**	$107,153
7	**Sewer--Use Charges**	$210,000
8	**Carbon Replacement**	$70,000
9	**Sludge Disposal (non-hazardous)**	$50,000
10	**Maintenance Materials and Repair Labor**	$112,347
11	**Maintenance and Repair Material**	$29,565
12	**Plant Services (shops, storehouses, laboratories)**	$21,000
13	**Depreciation**	
14	**Property Insurance and Taxes**	$29,565
15	**Personnel Insurance and Taxes**	$4,500
16	**Overhead (purchasing department, legal activities)**	$10,500
17	**Indirect Costs**	
	Engineering	
	Field Inspection/Technical Support	
	Construction Management	
	Contractor Profit and Overhead	
	Contingency	

Note: All numbers presented in Table 9-1 are based on preliminary cost estimates. These numbers will change based upon the final system design.

sxayadi0\ciba\CIBA-O&M.XLS

TABLE 9-1, CONTINUED

CIBA-GEIGY CORPORATION, CRANSTON, RI
POWER REQUIREMENTS

	EQUIPMENT DESCRIPTION	HP	PHASE	VOLTAGE	kW-hr	QUANTITY	TOTAL kW-hr	UNIT COST ($/kW-hr)	COST ($/yr)
	PUMPS:								
1	RECOVERY WELL PUMPS	3	3	230	24,506	3	73,518	0.11	8,087
2	TRANSFER PUMPS (Equalization tank # 1 to Oxidation tank)	5	3	230	40,844	2	81,687	0.11	8,986
3	TRANSFER PUMPS (Equalization tank # 2 to Oxidation tank)	3	3	230	24,506	1	24,506	0.11	2,696
4	TRANSFER PUMPS (Lift station # 1 to Strippers)	3	3	230	24,506	2	49,012	0.11	5,391
5	TRANSFER PUMPS (Lift station # 2 to aqueous phase GAC)	3	3	230	24,506	2	49,012	0.11	5,391
6	TRANSFER PUMPS (Lift station # 3 to equalization tank # 1)	5	3	230	40,844	2	81,687	0.11	8,986
	MIXERS:								
1	EQUALIZATION TANK # 1	10	3	230	81,687	1	81,687	0.11	8,986
2	EQUALIZATION TANK # 2	3	3	230	24,506	1	24,506	0.11	2,696
3	OXIDATION TANK	2	3	230	16,337	1	16,337	0.11	1,797
4	pH ADJUSTMENT TANK	2	3	230	16,337	1	16,337	0.11	1,797
5	FLASH MIXING ZONE	0.50	1	115	4,084	1	4,084	0.11	449
6	FLOCCULATION ZONE	0.75	1	115	6,127	1	6,127	0.11	674
6A	SLUDGE RAKE	0.5	1	115	4,084	1	4,084	0.11	449
7	FINAL pH ADJUSTMENT TANK	1	3	230	8,169 0	1	8,169	0.11	899
8	LIFT STATION # 3	1	3	230	8,169	1	8,169	0.11	899
	METERING PUMPS:								
1	CHEMICAL FEED	0.5	1	115	4,084	3	12,253	0.11	1,348
2	POLYMER FEED	0.5	1	115	4,084	1	4,084	0.11	449
3	PEROXIDE FEED	0.5	1	115	4,084	1	4,084	0.11	449
	BLOWERS:								
1	OXIDATION TANK	2	3	230	16,337	1	16,337	0.11	1,797
2	AIR STRIPPER	5	3	230	40,844	1	40,844	0.11	4,493
3	COVERED TANK HEADSPACE PURGE	5	3	230	40,844	3	122,531	0.11	13,478
4	MAKE-UP AIR FOR TREATMENT AREA	5	3	230	40,844	2	81,687	0.11	8,986
5	VAPOR TRANSPORT	5	3	230	40,844	2	81,687	0.11	8,986
	COMPRESSOR FOR OPERATING THE FOLLOWING EQUIPMENT:								
1	BACKWASHING SAND FILTER								
2	AIR OPERATED PUMPS								
3	AIR OPERATED VALVES								
4	CARBON TRANSFER SYSTEM								
5	AIR OPERATED FILTER PRESS FEED PUMP SYSTEM								
6	FILTER PRESS OPERATIONS								
	Compressor Requirement (refer to compressed air requirements Table)	10	3	230	81,687	1	81,687	0.11	8,986
	DEHUMIDIFIER:					1			

Note: All numbers presented in Table 9-1 are based on preliminary cost estimates.
These numbers will change based upon the final system design.

TABLE 9-1, CONTINUED

CIBA-GEIGY CORPORTION, CRANSTON, RI
CITY WATER REQUIREMENTS

	SYSTEM	QUANTITY	UNIT COST ($/gal)	USAGE RATE @ DELIVERY PRESSURE	DURATION	COST ($/yr)
1	FLOOR WASHING - FIRST FLOOR	1	0.084	20gpm @ 30 psig for 20 minutes	ONCE/MONTH	403
2	FLOOR WASHING - SECOND FLOOR	1	0.084	20gpm @ 30 psig for 20 minutes	ONCE/MONTH	403
3	FLOOR WASHING - CONCRETE DIKE	1	0.084	20gpm @ 30 psig for 20 minutes	ONCE/MONTH	403
4	POLYMER DILUTION SYSTEM	1	0.084		CONTINUOUS	
5	FOR AQUEOUS PHASE GAC SLURRY	1	0.084	100 gpm @ 30 psig (minimum) for 4 to 6 hours	ONCE/SIX MONTHS	6,048
6	FOR BACKWASHING OF AQUEOUS PHASE GAC BEDS	1	0.084	625 gpm @ 30 psig (minimum) for 15 minutes	ONCE/TWO WEEKS	18,900
7	PIPELINE FLUSHING AND WASHING EQUIPMENT	1	0.084	-	AS NEEDED	
8	EMERGENCY EYE WASH/FACE WASH STATION (BOTH FLOORS)	2	0.084	5.5 gpm @ 30 psi (minimum) for 15 minutes	AS NEEDED	
9	EMERGENCY SHOWER STATION (BOTH FLOORS)	2	0.084	30 gpm @ 30 psi (minimum) for 15 minutes	AS NEEDED	
10	SOIL VAPOR EXTRACTION SYSTEM (PUMP PRIMING)	1	0.084	NO PRESSURE REQUIREMENTS	AS NEEDED	

Note: All numbers presented in Table 9-1 are based on preliminary cost estimates.
These numbers will change based upon the final system design.

TABLE 9-1, CONTINUED

CIBA-GEIGY CORPORATION, CRANSTON, RI
CHEMICAL REQUIREMENTS

	CHEMICAL FEED SYSTEM	QUANTITY	UNIT COST ($/lb)	TOTAL USAGE (gallons/year)	COST ($/yr)
1	25% NaOH SYSTEM FOR pH ADJUSTMENT TANK	2	0.29	24455	75,562
2	5% H2SO4 SYSTEM FOR FINAL pH ADJUSTMENT TANK	1		9125	
3	POLYMER SYSTEM FOR FLASH MIXING ZONE	1	1.59		
4	STANDBY H2O2 (30 ppm) SYSTEM FOR OXIDATION TANK	2	0.43	-	

Note: All numbers presented in Table 9-1 are based on preliminary cost estimates. These numbers will change based upon the final system design.

TABLE 9-1, CONTINUED

CIBA-GEIGY CORPORATION, CRANSTON, RI
COMPRESSED AIR REQUIREMENTS

	COMPRESSED AIR SYSTEM	QUANTITY	USAGE RATE @ DELIVERY PRESSURE	DURATION
1	AIR OPERATED VALVES			CONTINUOUS
2	BACKWASHING SAND FILTER	1	2-3 SCFM @ 15-25 psig	CONTINUOUS
3	CARBON TRANSFER	1	100 SCFM @ 30 psig (for adsorber)	ONCE/SIX MONTHS FOR 4-6 HOURS
		1	100 SCFM @ 15 psig (for transport trailer)	ONCE/SIX MONTHS FOR 4-6 HOURS
4	BLOWDOWN FOR FILTER PRESS	1	AIR REQUIREMENT INCLUDED IN FILTER PRESS OPERATION (ITEM 7)	TWICE/WEEK FOR 4-6 HOURS
5	DIAPHRAGM PUMPS	1	5 SCFM @ 45 psi (sludge recycle line)	ABOUT 30% OF TIME
		1	15 SCFM @ 75 psi (lamella gravity settler to sludge holding tank)	ABOUT 30% OF TIME
6A	FILTER PRESS FEED PUMP SYSTEM - FILL PUMP	1	95 SCFM @ 50 psi	TWICE/WEEK FOR 2-3 HOURS
6B	FILTER PRESS FEED PUMP SYSTEM - PRESS PUMP	1	40 SCFM @ 90 psi	TWICE/WEEK FOR 2-3 HOURS
7	FILTER PRESS OPERATIONS	1	30 SCFM @ 100 psi	TWICE/WEEK FOR 4-6 HOURS

Note: All numbers presented in Table 9-1 are based on preliminary cost estimates.
These numbers will change based upon the final system design.